REMTECH INC. RTR 041-02

ORBITAL FLIGHT TEST SHUTTLE EXTERNAL TANK AEROTHERMAL FLIGHT EVALUATION

VOLUME III

June 1986

by

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Contract NAS8-33373

for

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George C. Marshall Space Flight Center
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APPENDIX C

COMPARISON OF INTERFERENCE FACTORS BETWEEN OFT FLIGHT, PREDICTION AND IH-97A TEST DATA

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TECHNICAL NOTE

TITLE: Comparison Of Interference Factors Between OFT Flight, Prediction and IH-97A Test Data (From RTN 041-15)

DATE: July 26, 1983

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CONTRACT NO: NAS8-33373

PREPARED FOR: George C. Marshall Space Flight Center

DESCRIPTION

The purpose of this note is to present the OTS turbulent interference factor (h_i/h_u) - Mach number plots comparing OFT flight data, prediction and IH-97A data. They are given in the following four sets of plots which are attached as Appendix to this note:

Set 1 -	STS-1	pp. 1.1 - 1.21
Set 2 -	STS-2	pp. 2.1 - 2.34
Set 3 -	STS-3	pp. 3.1 - 3.34
Set 4 -	STS-4	pp. 4.1 - 4.36

A typical plot compares h_i/h_u data derived from flight, h_i/h_u prediction based on the wind tunnel data base, and h_i/h_u data obtained from test IH-97A. The data reduction procedure for the flight data is documented elsewhere (Ref. 1). The prediction procedure is described in detail for STS-1 in Ref. 2. As far as the ET acreage data in test IH-97A, the tabulated data are reported in Ref. 3. It should be emphasized that Ref. 3 contains only the acreage h_i/h_u data and not the protuberance h_i/h_u data. For ease of the user, the h_i/h_u data from test IH-97A for the acreage DFI locations are summarized in Tables *.1 and *.2 for each of the STS flights. The gages 9017 (Island 12), 9018 (117), 9022 (123),

9001, 9042, 9045, 9046, and 9047 were remodeled for flights beyond STS-1 by using the observed flight data from STS-1. So care should be exercised before using the predicted h_I/h_u in the STS-1 mission. The protuberance data are being worked elsewhere and have not yet been documented fully. As a consequence, the plots for acreage DFI locations contain the h_I/h_u data from flight, wind tunnel data base and IH-97A test, whereas the plots pertaining to protuberance gages contain only the flight and prediction interference factors. It should further be cautioned to the user that for the h_I/h_u data pertaining to the protuberance gages located on the A-frame and the aft attach structure, the undisturbed value of the convective film coefficient (h_u) is based on the flat-plate value calculated on the ET skin. It could easily be changed to the corresponding undisturbed value on the protuberance by a multiplier while considering the turbulent regime.

REFERENCES

1. Praharaj, S. C. and Engel, C. E., ''STS Orbital Flight Test (OFT) External Tank Aerothermal Flight Evaluation,'' REMTECH, Inc., Huntsville, Alabama, Technical Report (Under Preparation).

2. Praharaj, S. C. and Engel, C. E., '' STS-1 ET Aerothermal Flight Evaluation,'' REMTECH, Inc., Huntsville, Alabama, Technical Report 041-1, April 1982.

3. Somers, R. E., and Warmbrod, J. D., ''External Tank Acreage Heat Transfer Data Tables For Test IH-97A,'' REMTECH, Inc., Huntsville, Alabama, Report RM 032-7, March 1983.

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APPENDIX

SET - 1

STS-1 pp. 1.1 - 1.21

Table [illegible].1 STS-1 DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9001A	350.0	180.0	Ind. Gage	40° Cone
T07R9011A	976.0	25.0	Island 18	Intertank
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9013A	1110.4	2.5	Island 17(3)	Intertank
T07R9014A	937.4	288.6	Island 16	Intertank
T07R9015A	956.2	270.0	Island 15	Intertank
T07R9016A	937.4	251.4	Island 14	Intertank
T07R9017A	948.5	180.0	Island 12	Intertank
T07R9018A	1098.5	2.5	Island 17(2)	Intertank
T07R9019A	1084.4	2.5	Island 17(1)	Intertank
T07R9021A	1030.1	270.0	Island 20	Intertank
T07R9022A	1073.8	180.0	Island 23	Intertank
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2100.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2035.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

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Table 1.2

STS-1 ET INTERFERENCE FACTORS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9001	5029	1.100	1.158	1.079	1.587	1.951	2.141	2.115
9017	5035	0.625	0.663	0.615	0.745	0.730	0.730	0.756
9016	5036	4.836	4.812	5.128	4.843	4.727	5.250	5.235
9015	5258	5.763	6.256	7.485	8.476	8.344	9.249	10.618
9014	5038	3.456	3.205	3.329	3.634	4.420	5.222	5.559
9011	5042	1.289	1.165	1.051	0.870	0.911	0.833	0.926
9021	5043	0.098	0.289	0.341	0.479	0.692	1.823	1.872
9019	5040	2.838	3.026	3.318	3.365	—	2.434	2.216
9018	5039	3.237	3.562	3.997	4.364	3.630	3.386	3.157
9013	5041	—	—	—	4.677	—	4.043	3.561

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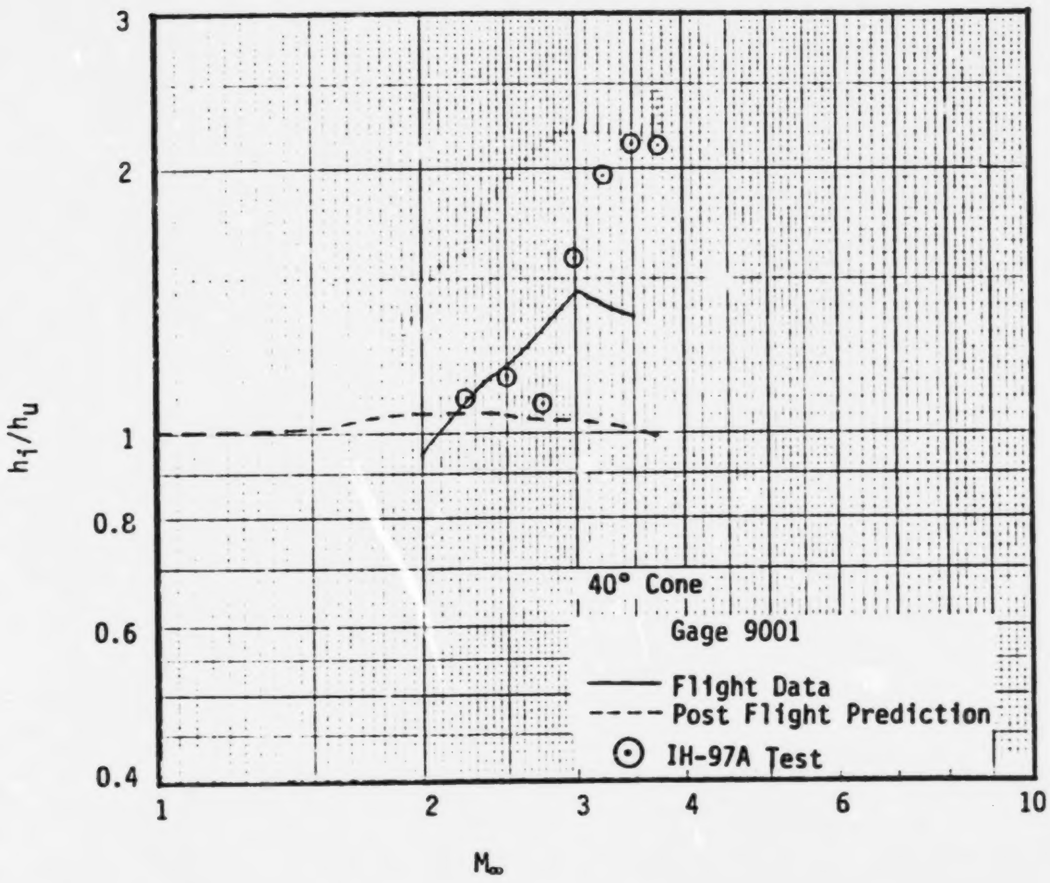

Fig. 1.1 STS-1 Post Flight Interference Factors for Gage 9001

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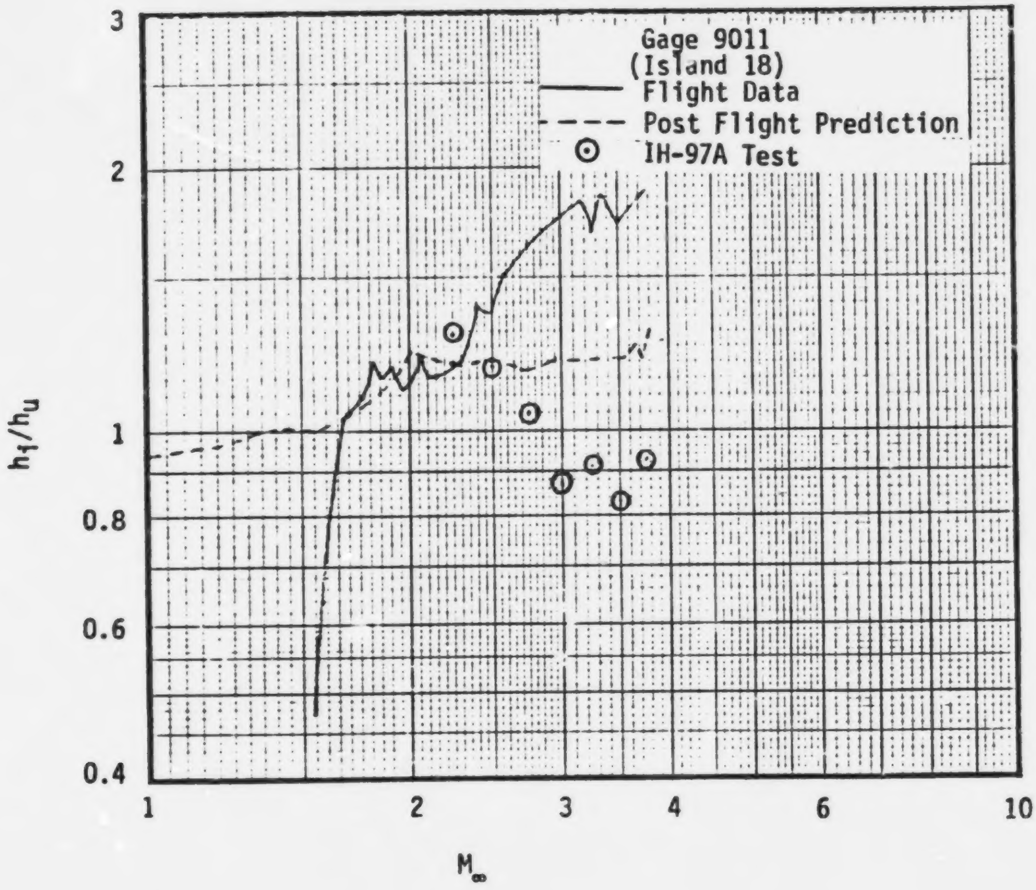

Fig. 1.2 STS-1 Post Flight Interference Factors for Gage 9011

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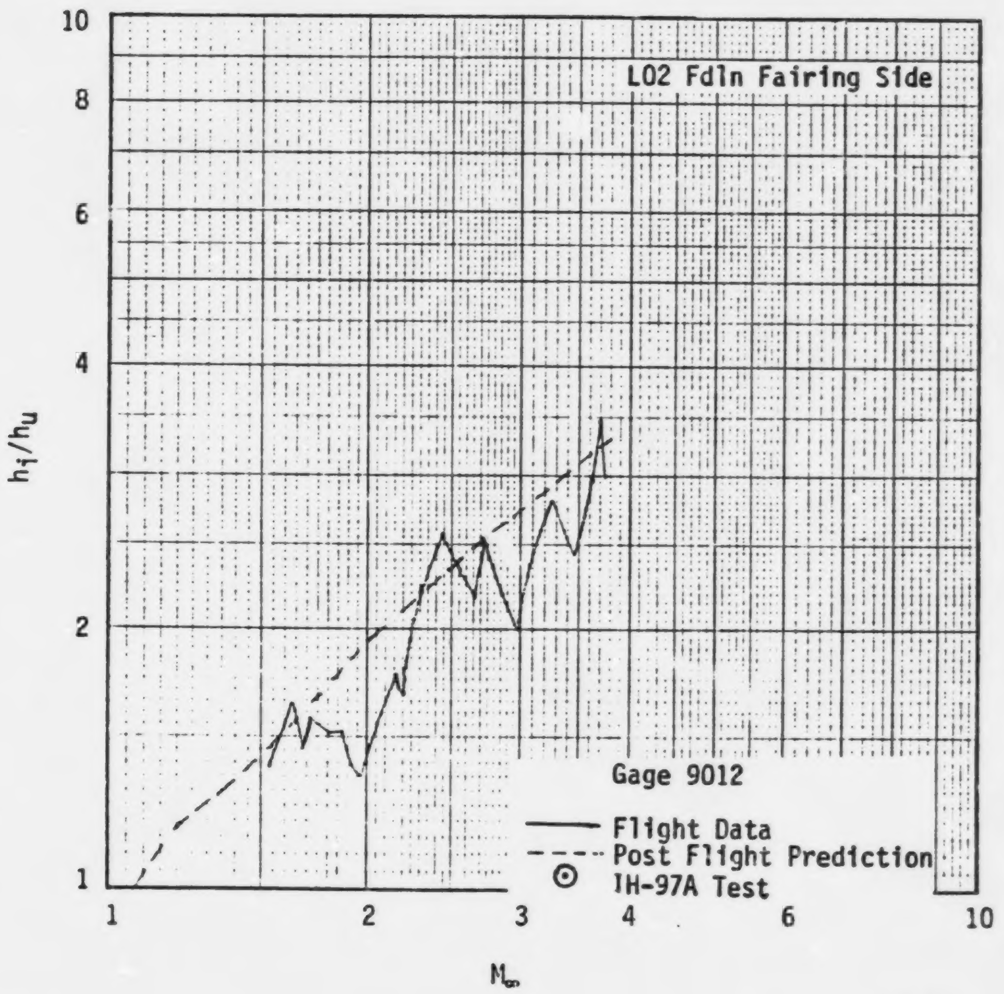

Fig. 1.3 STS-1 Post Flight Interference Factors for Gage 9012

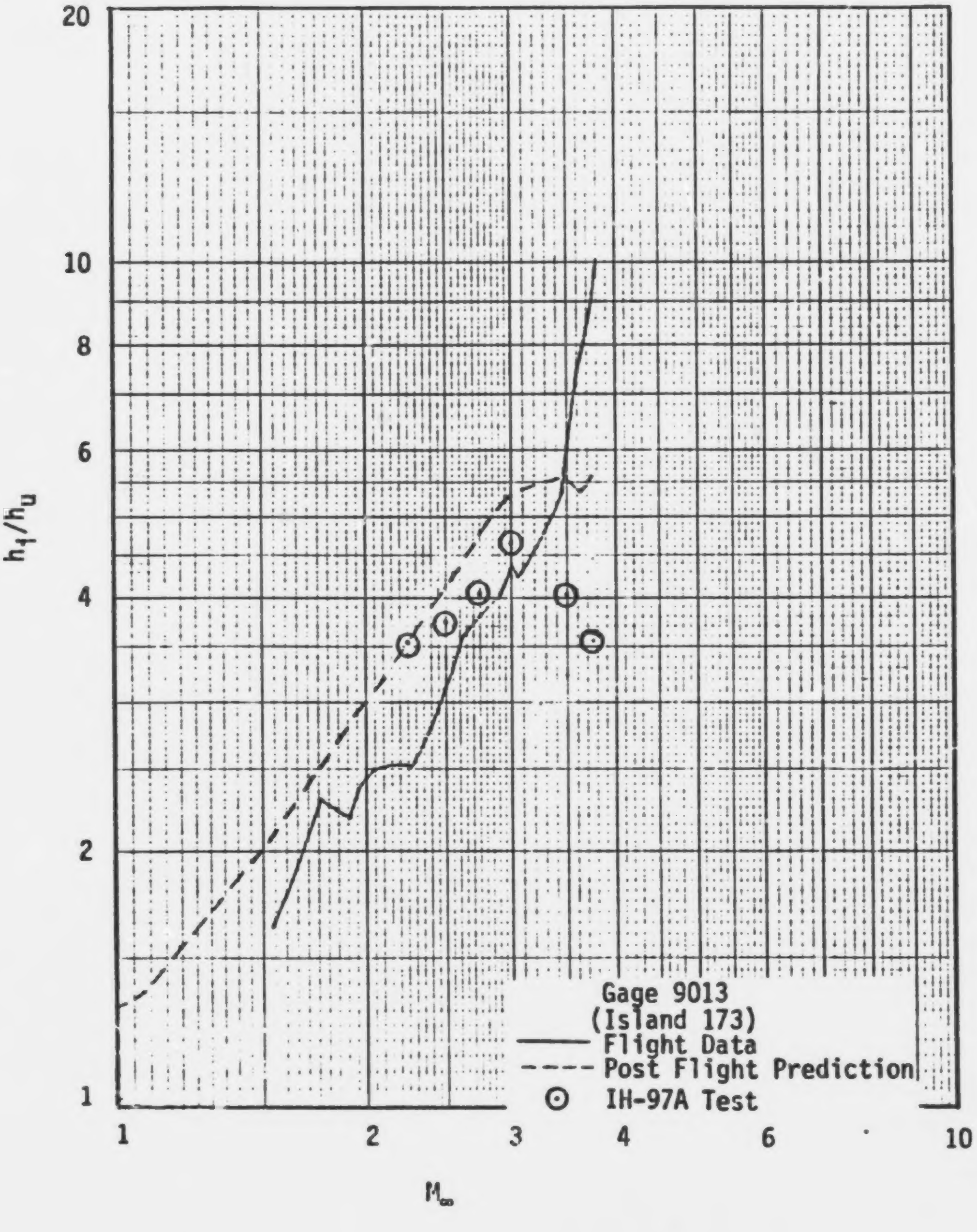

Fig. 1.4 STS-1 Post Flight Interference Factors for Gage 9013

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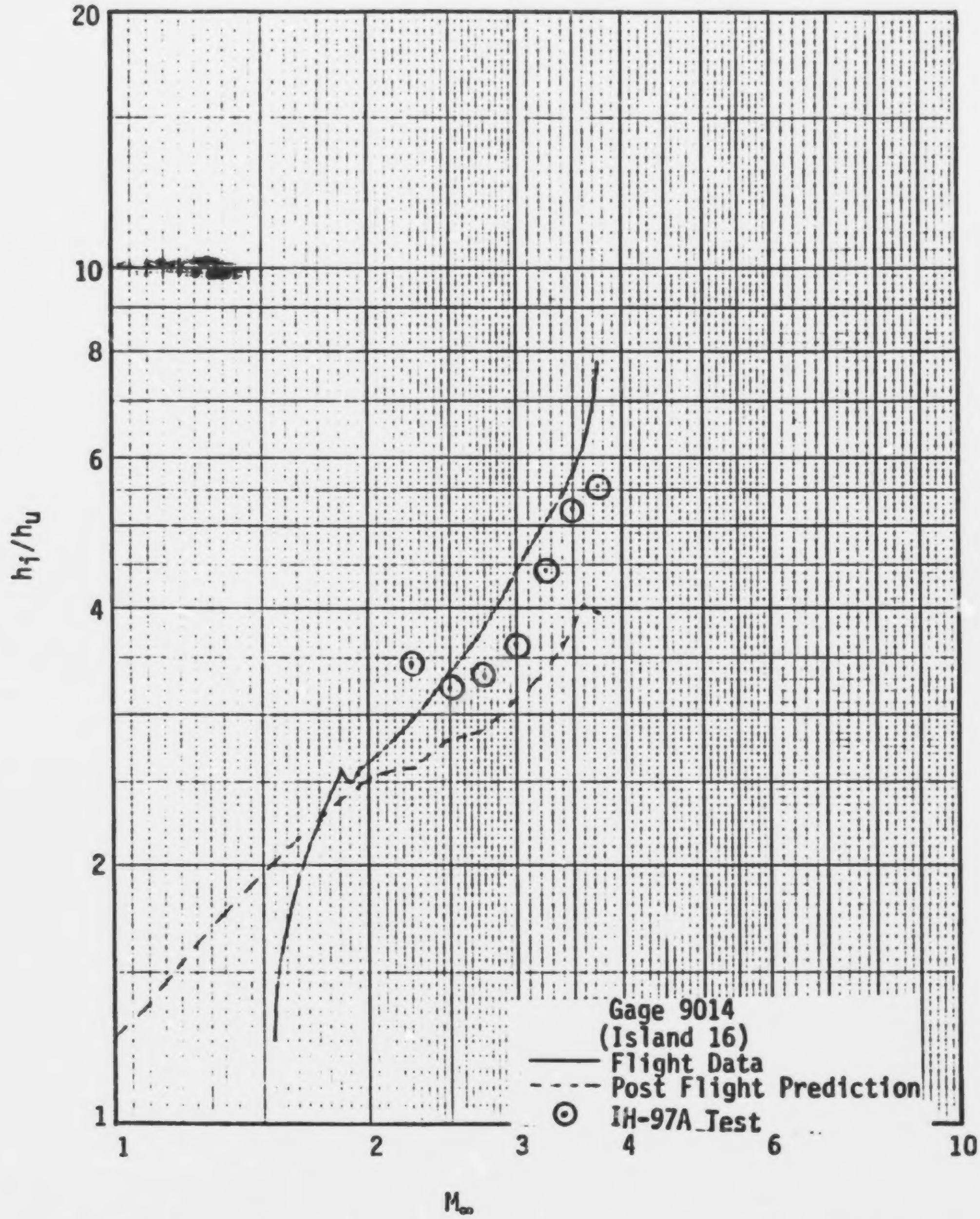

Fig. 1.5 STS-1 Post Flight Interference Factors for Gage 9014

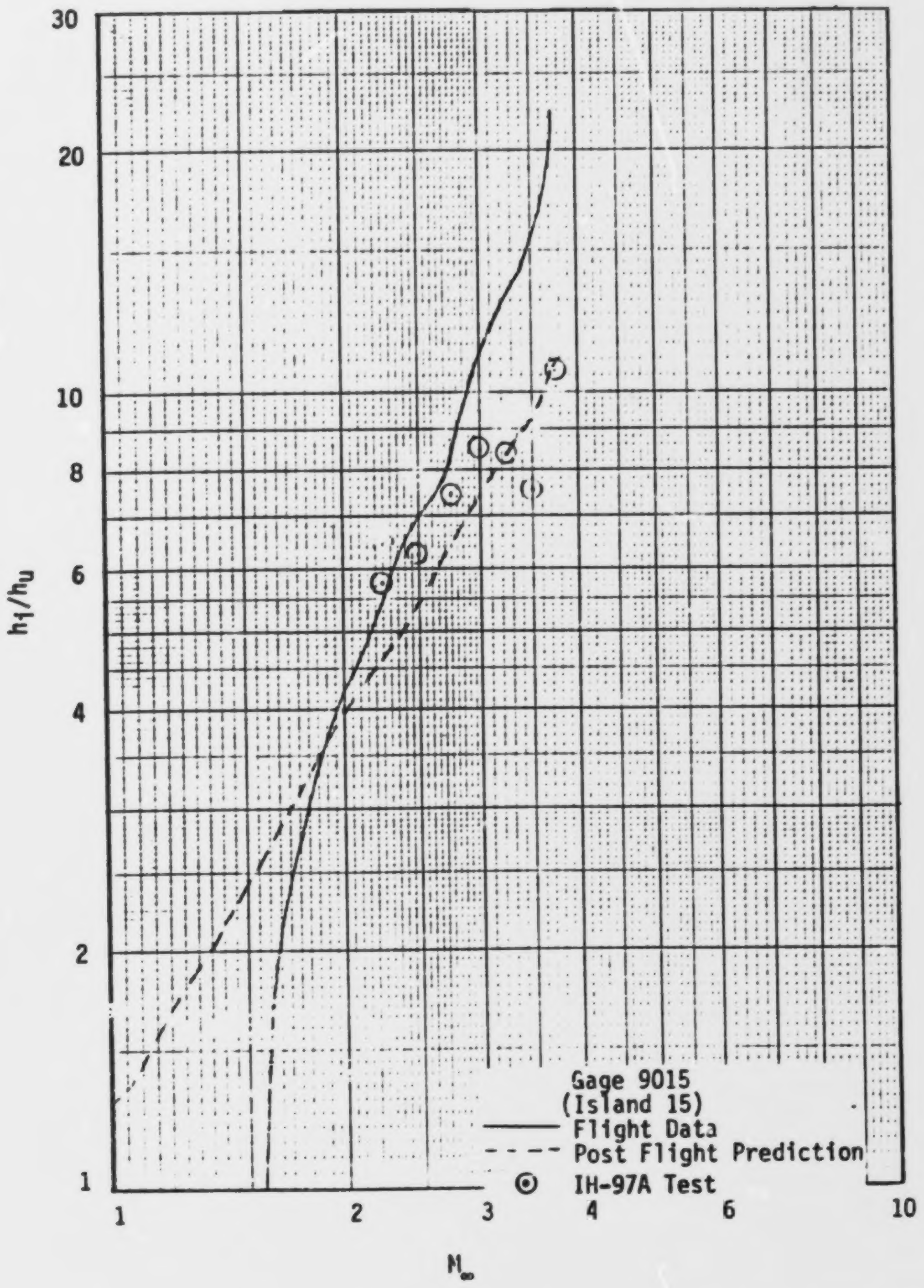

Fig. 1.6 STS-1 Post Flight Interference Factors for Gage 9015

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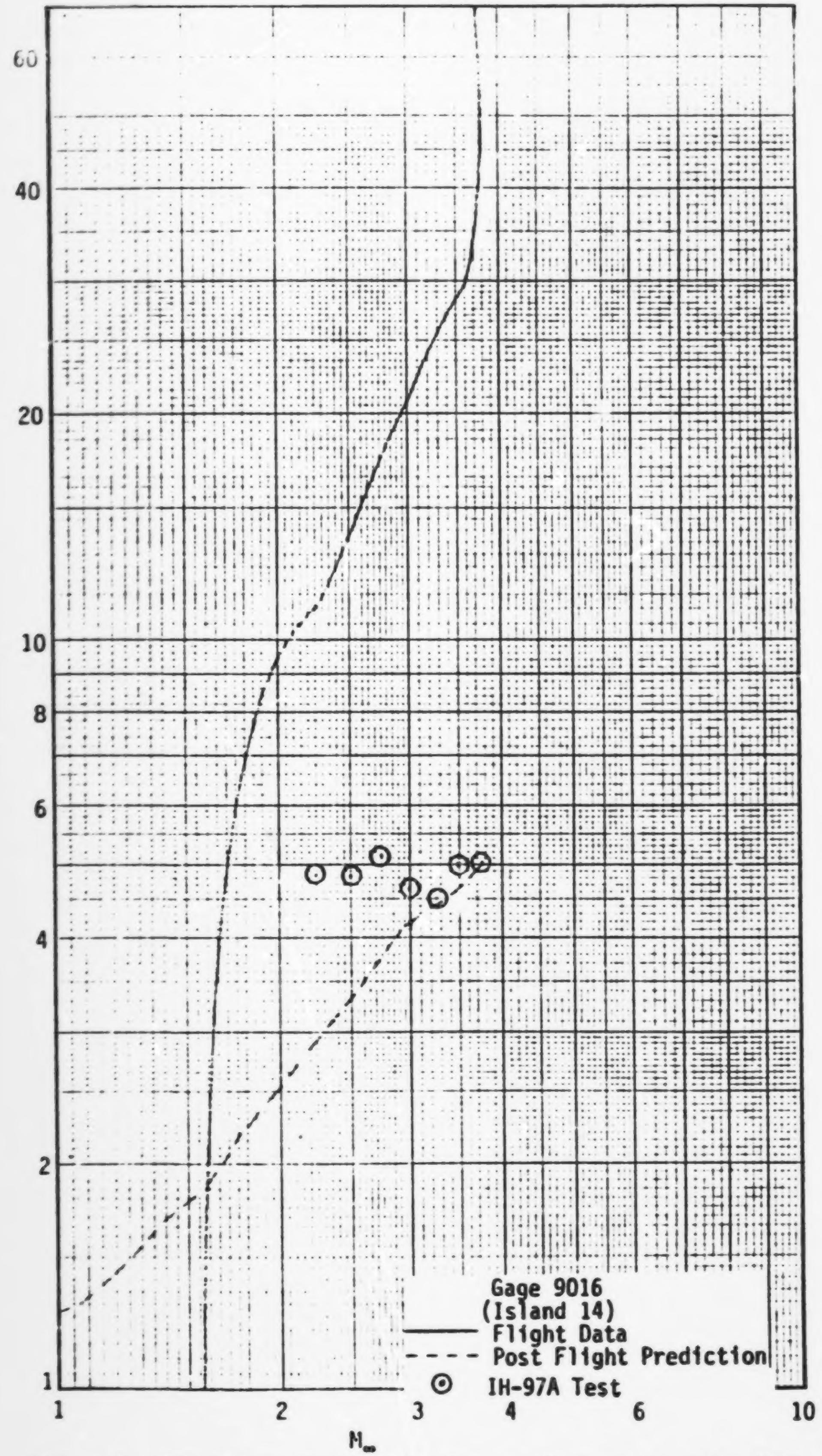

Fig. 1.7 STS-1 Post Flight Interference Factors for Gage 9016

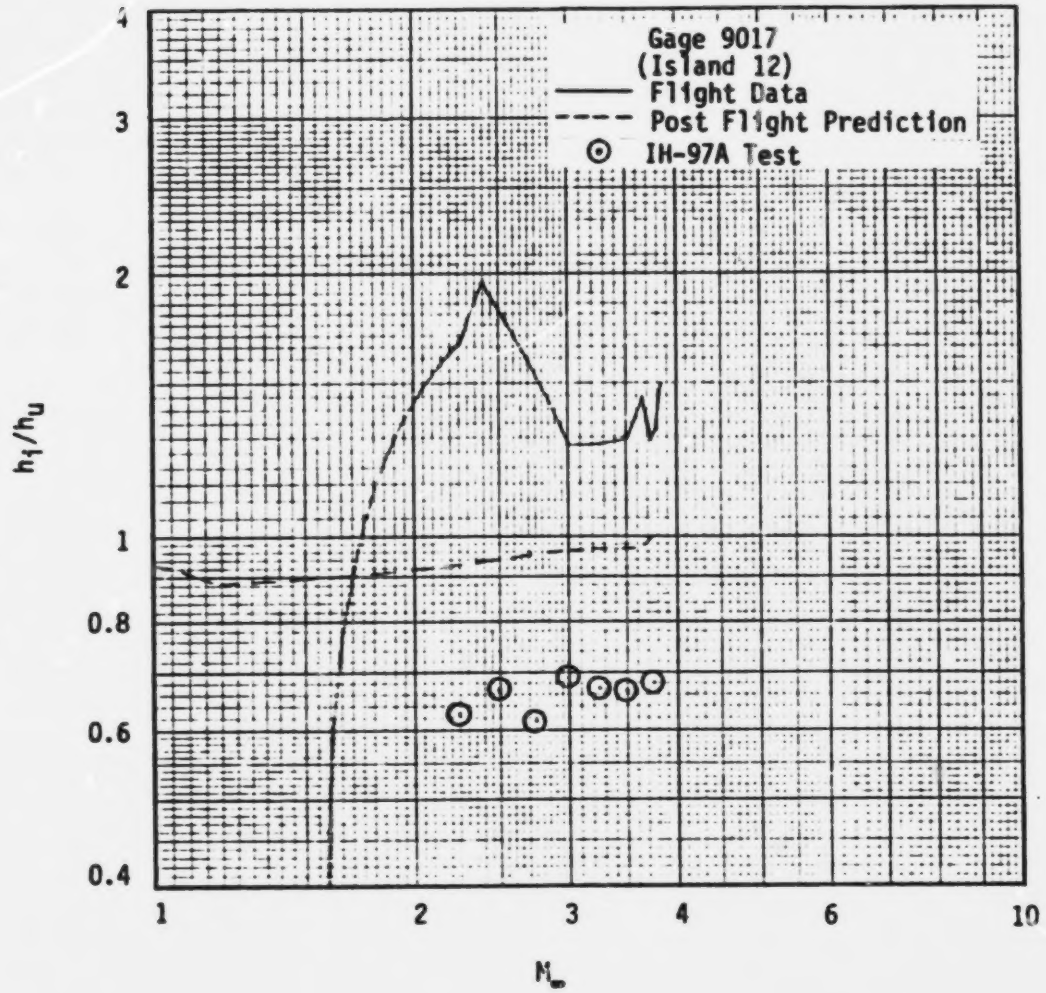

Fig. 1.8 STS-1 Post Flight Interference Factors for Gage 9017

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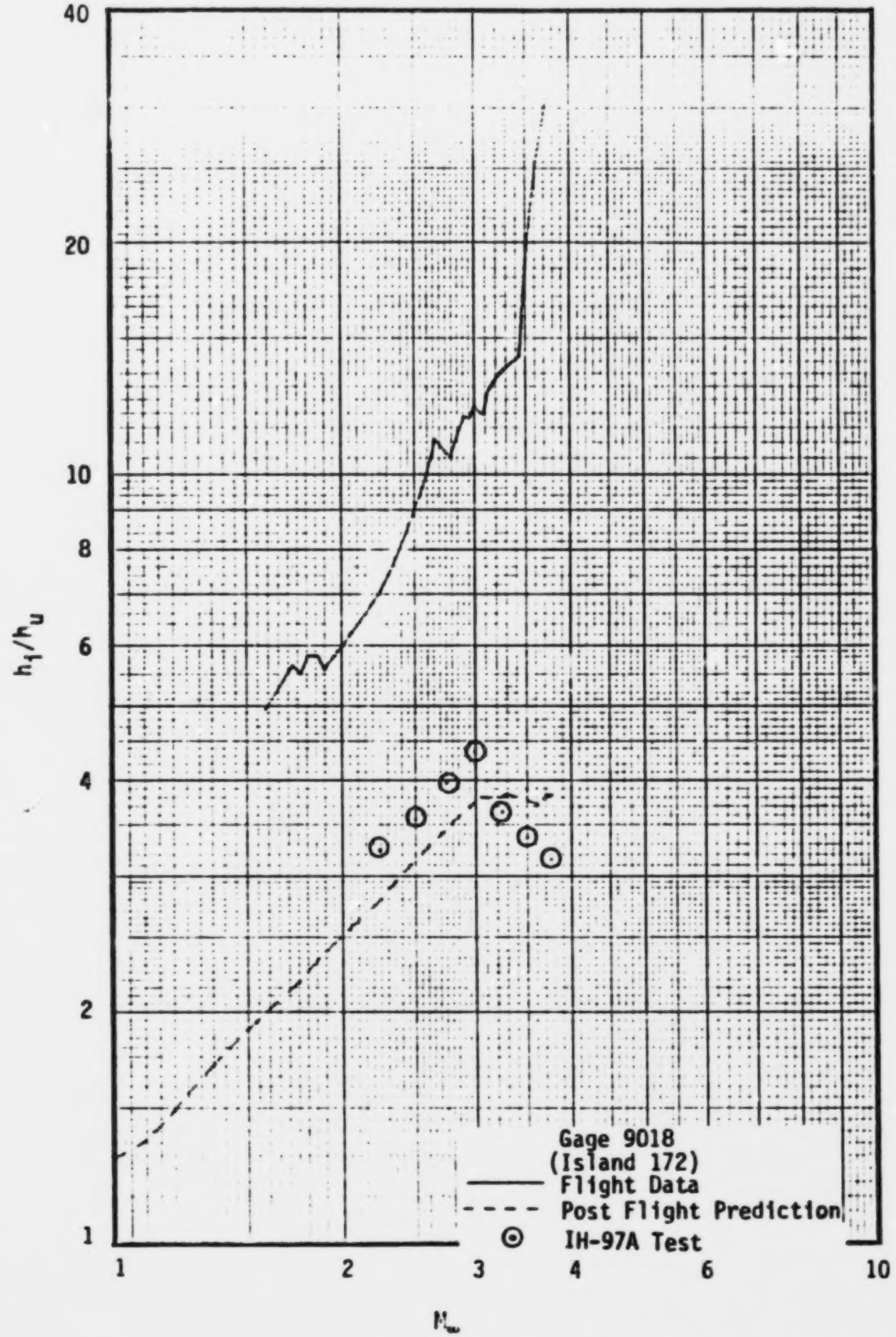

Fig. 1.9 STS-1 Post Flight Interference Factors for Gage 9018

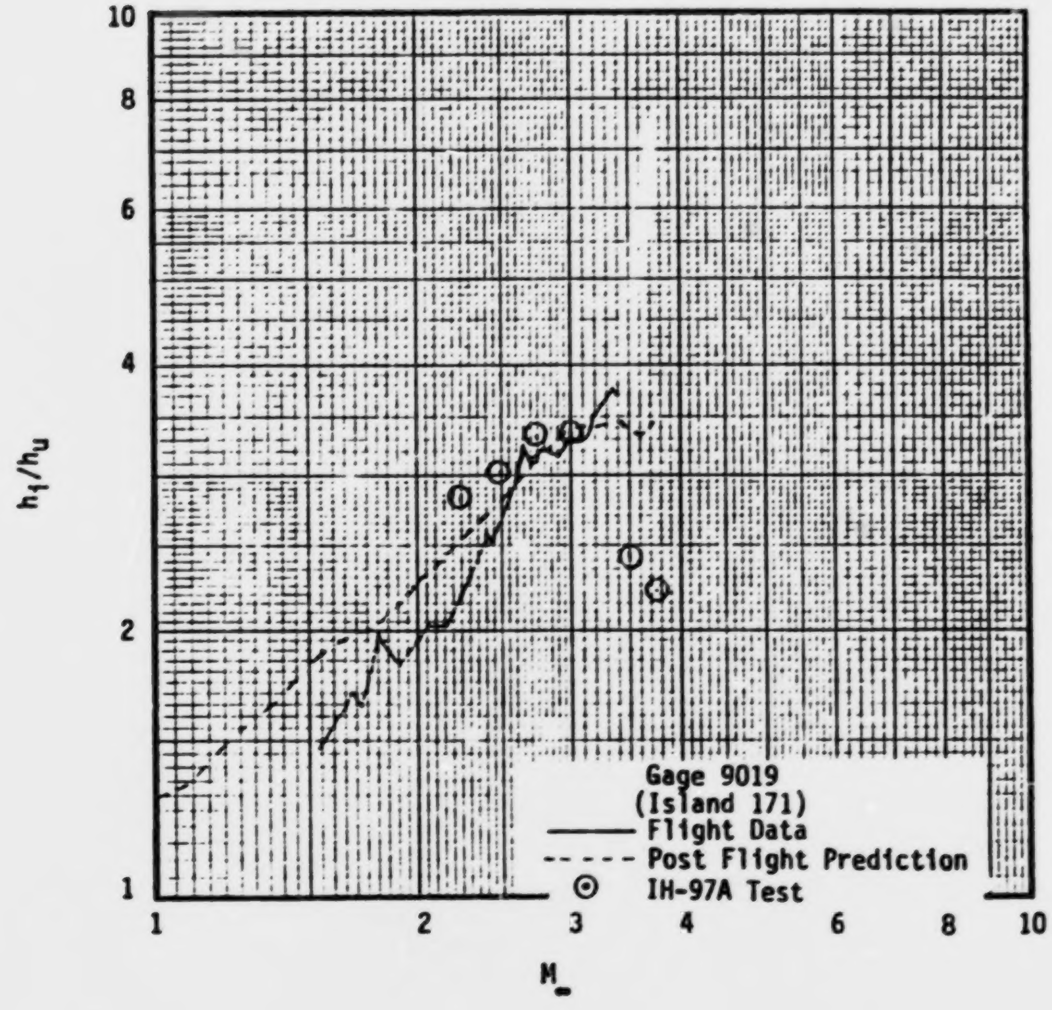

Fig. 1.10 STS-1 Post Flight Interference Factors for Gage 9019

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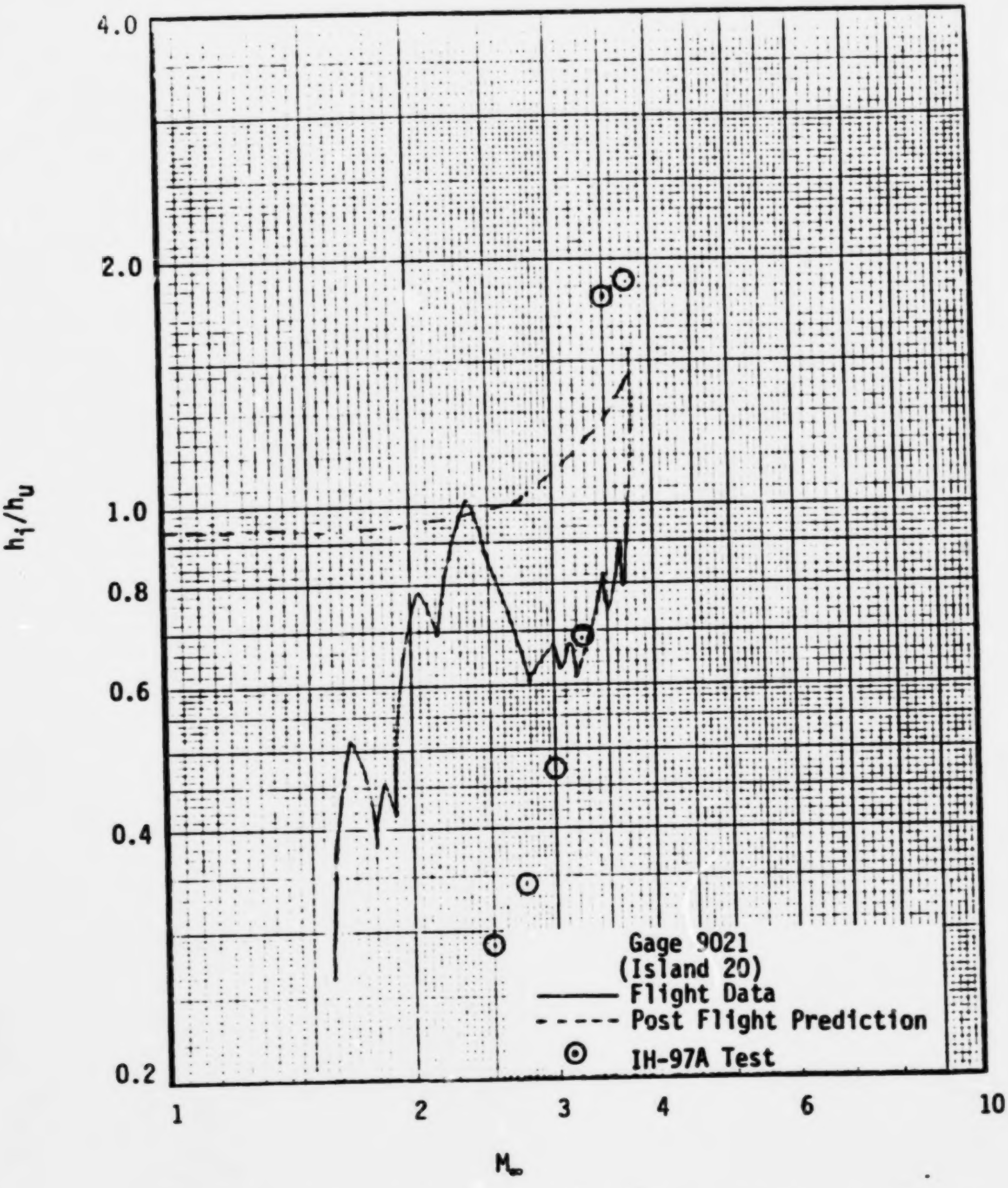

Fig. 1.11 STS-1 Post Flight Interference Factors for Gage 9021

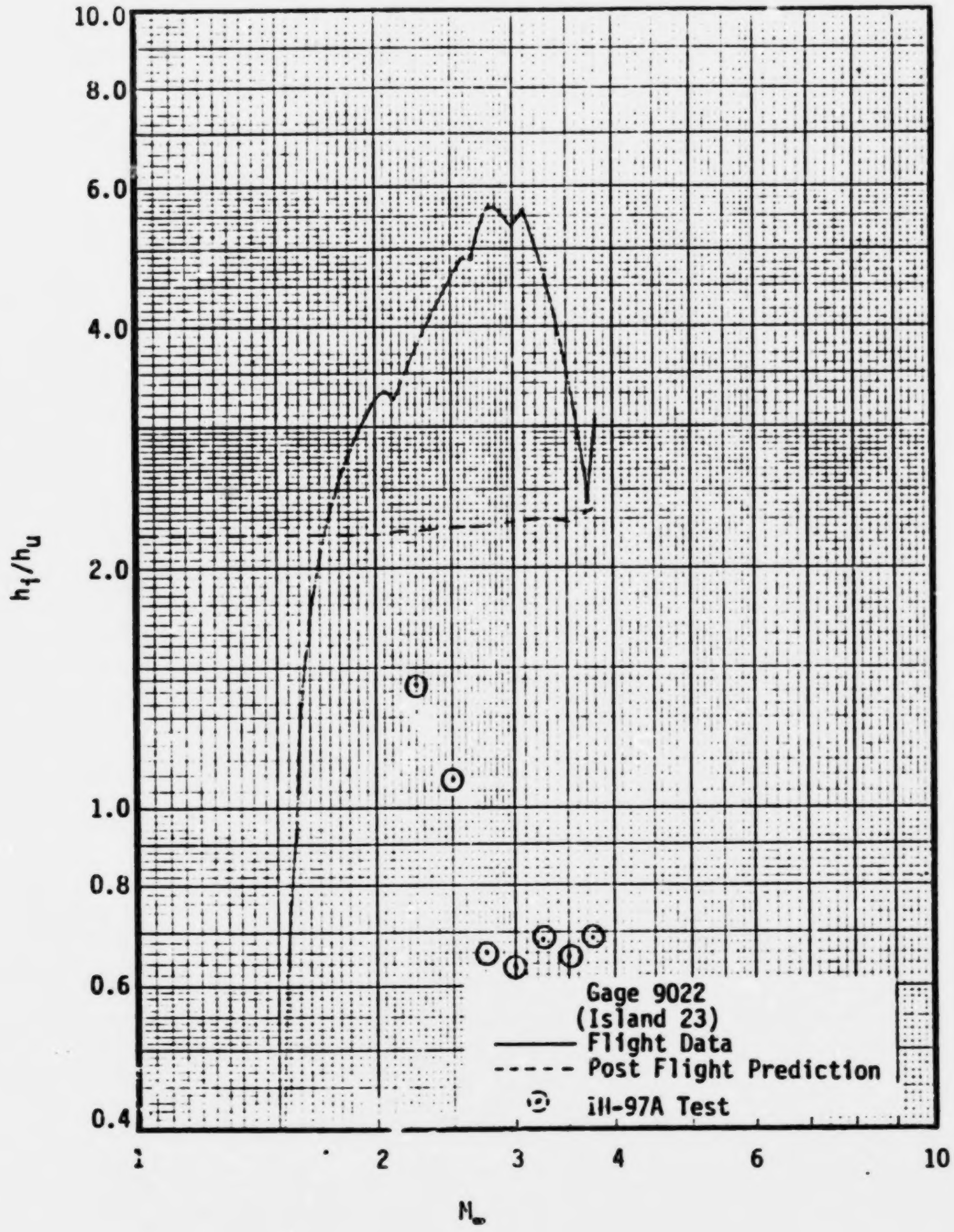

Fig. 1.12 STS-2 Post Flight Interference Factors for Gage 9022

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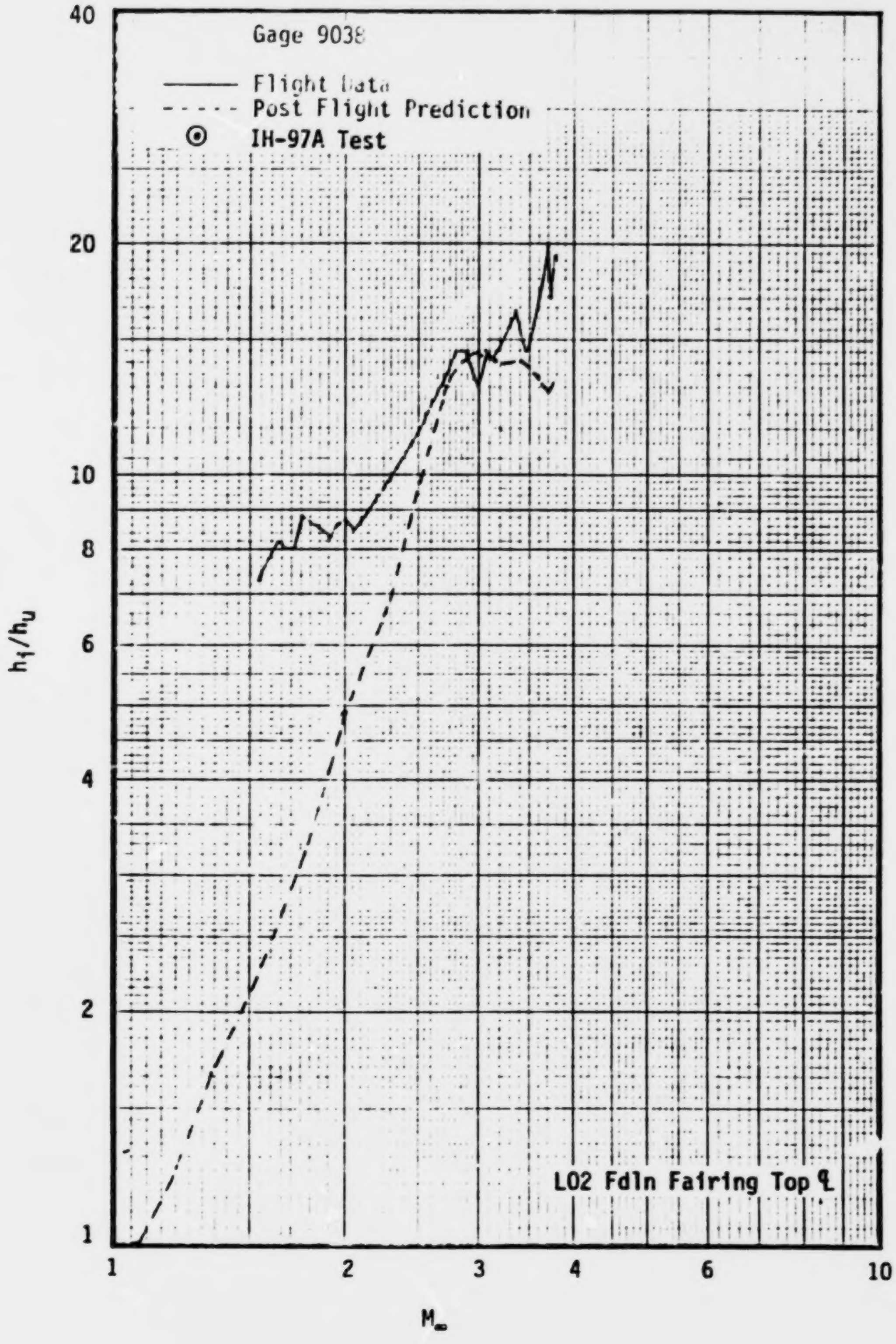

Fig. 1.13 STS-1 Post Flight Interference Factors for Gage 9038

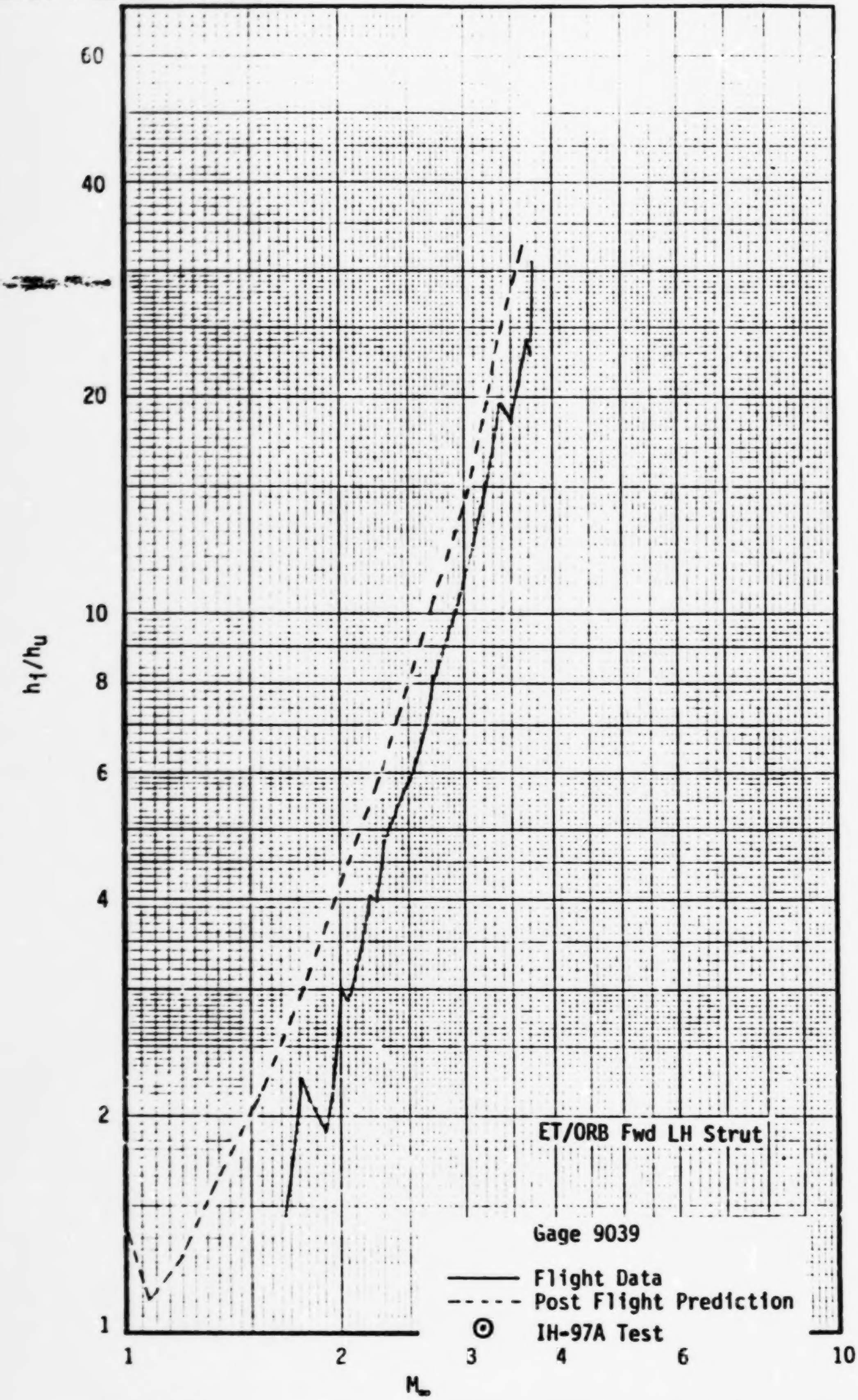

Fig. 1.14 STS-1 Post Flight Interference Factors for Gage 9039

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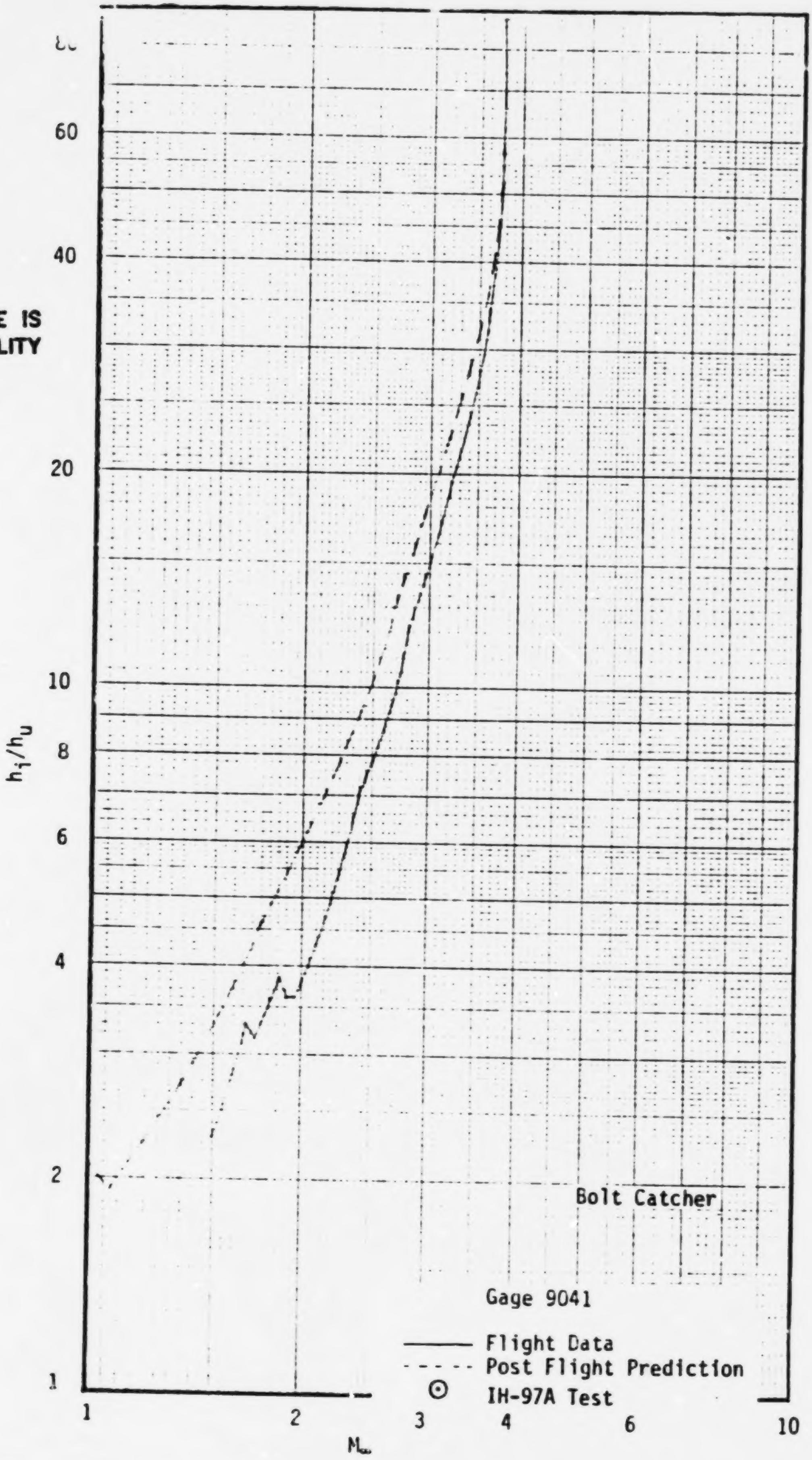

Fig. 1.15 STS-1 Post Flight Interference Factors for Gage 9041

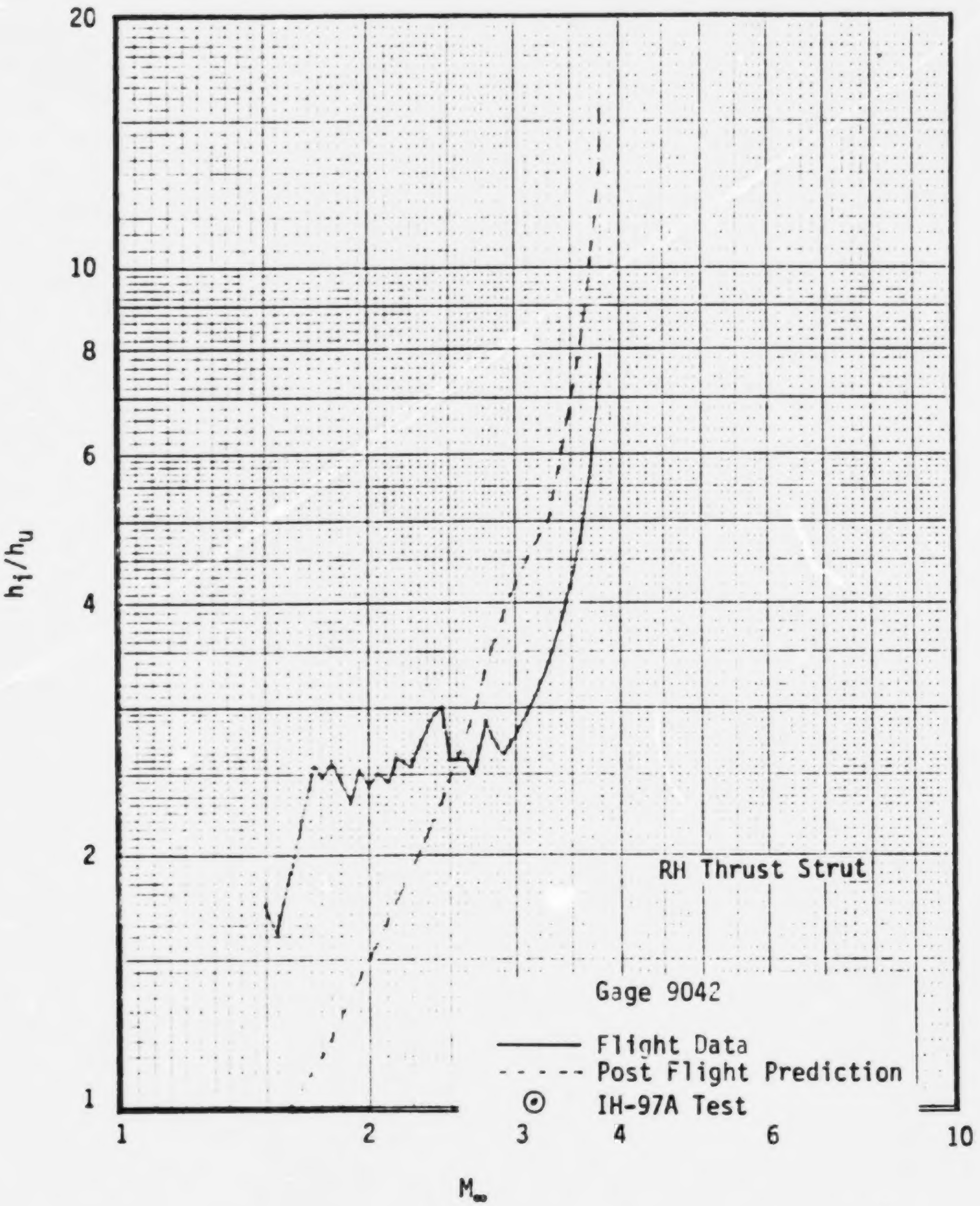

Fig. 1.16 STS-1 Post Flight Interference Factors for Gage 9042

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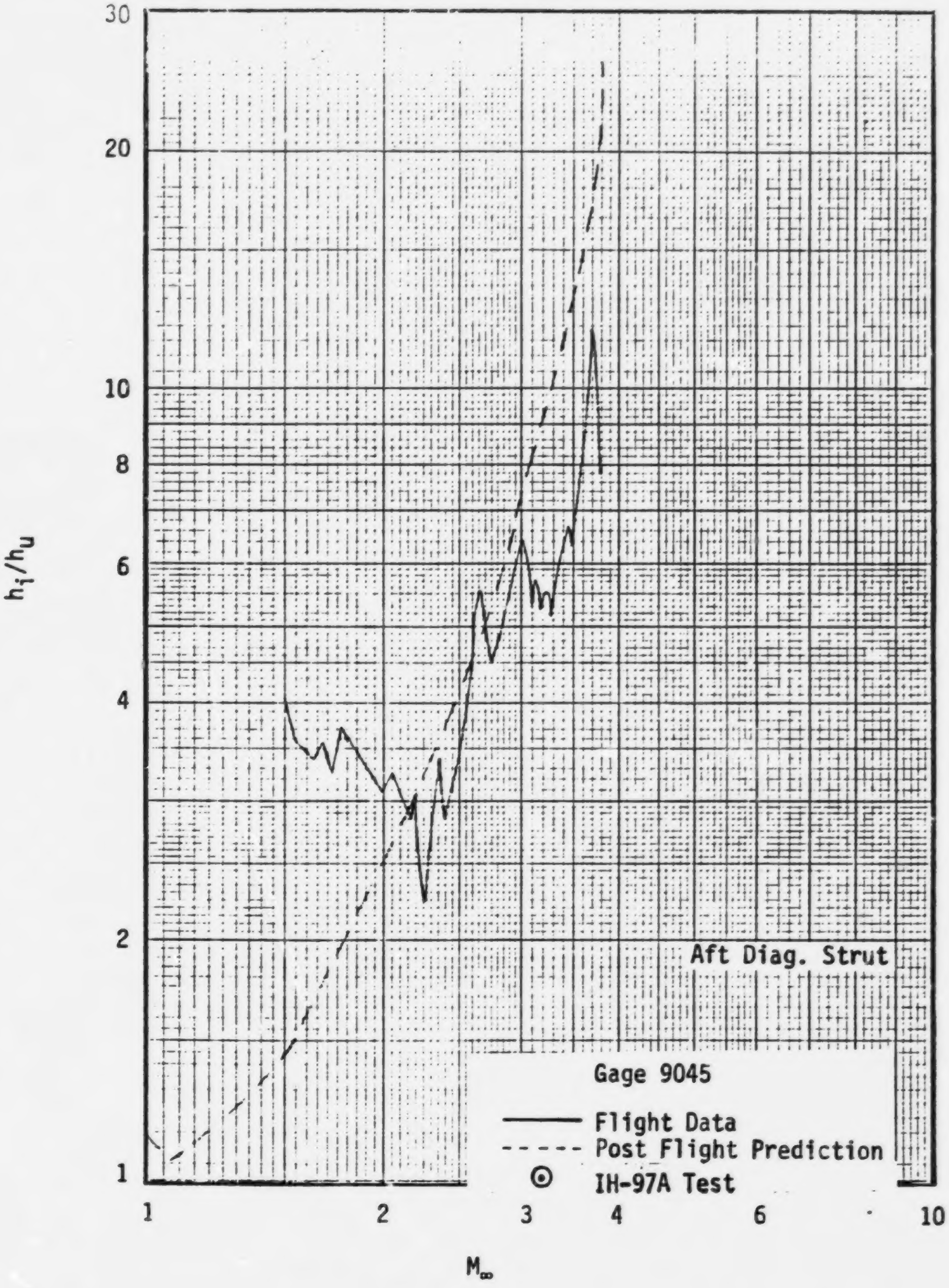

Fig. 1.17 STS-1 Post Flight Interference Factors for Gage 9045

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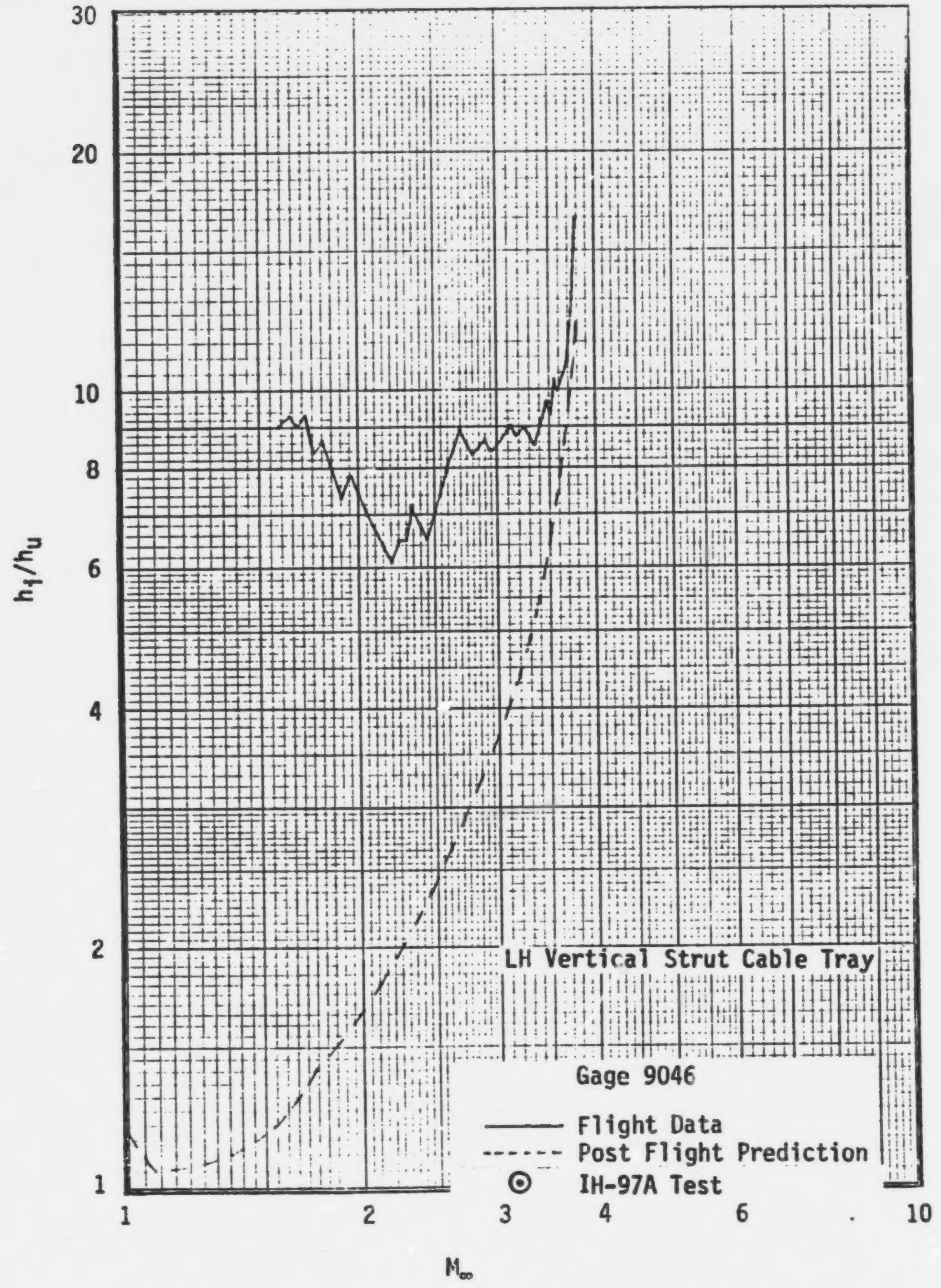

Fig. 1.18 STS-1 Post Flight Interference Factors for Gage 9046

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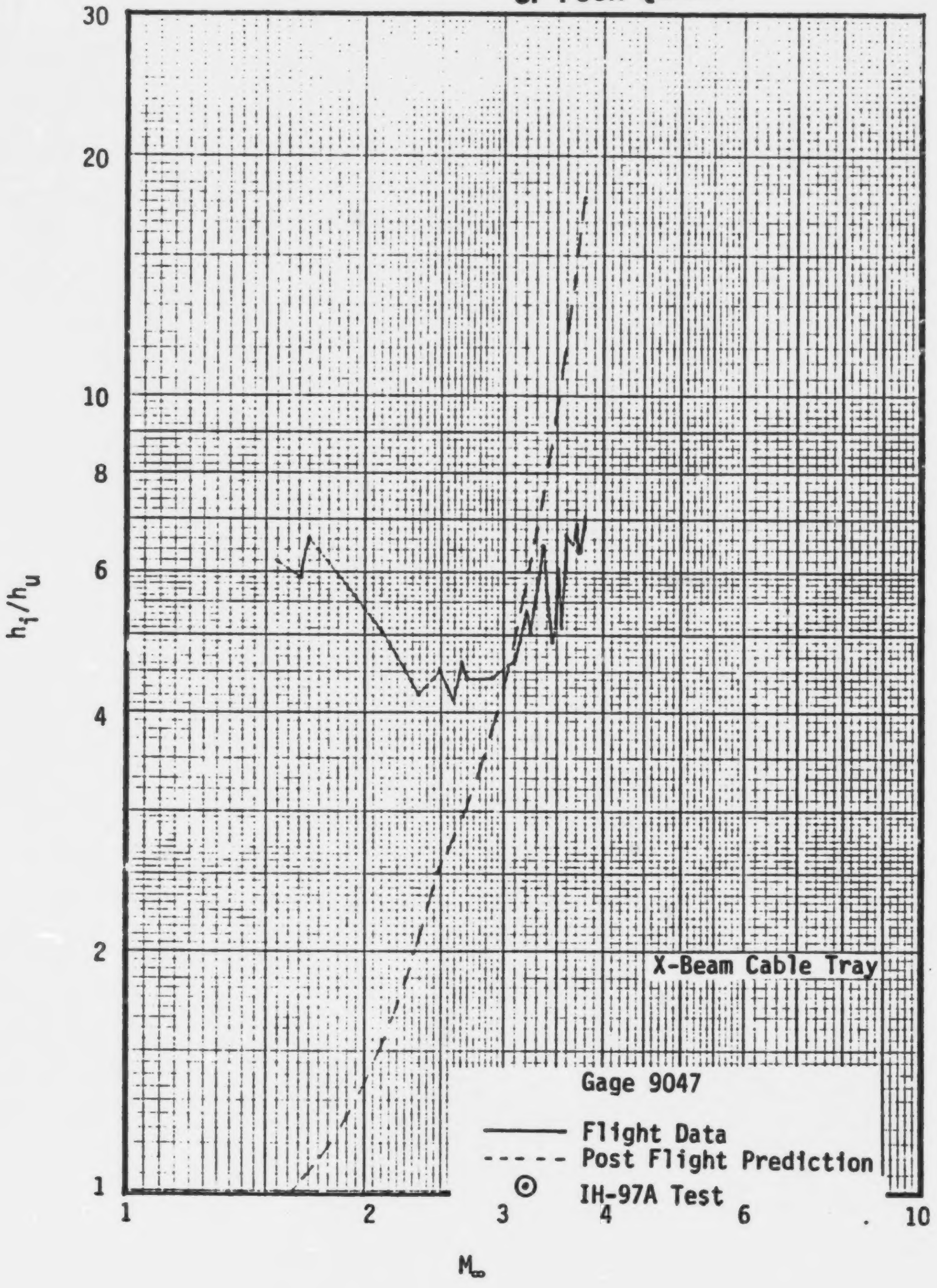

Fig. 1.19 STS-1 Post Flight Interference Factors for Gage 9047

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SET 2

STS-2 pp. 2.1 - 2.34

Table 2.1 STS-2 DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9001A	350.0	180.0	Ind. Gage	40° Cone
T07R9004A	467.4	264.0	Island 2	LO2 Tank
T07R9005A	467.4	174.0	Island 1	LO2 Tank
T07R9007A	672.5	270.0	Island 6	LO2 Tank
T07R9008A	672.5	180.0	Island 5	LO2 Tank
T07R9010A	825.5	270.0	Island 8	LO2 Tank
T07R9011A	976.0	25.0	Island 18	Intertank
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9013A	1110.4	2.5	Island 17(3)	Intertank
T07R9014A	937.4	288.6	Island 16	Intertank
T07R9015A	956.2	270.0	Island 15	Intertank
T07R9016A	937.4	251.4	Island 14	Intertank
T07R9017A	948.5	180.0	Island 12	Intertank
T07R9018A	1098.5	2.5	Island 17(2)	Intertank
T07R9019A	1084.4	2.5	Island 17(1)	Intertank
T07R9021A	1030.1	270.0	Island 20	Intertank
T07R9022A	1073.8	180.0	Island 23	Intertank
T07R9025A	1489.0	264.4	Island 29	LH2 Barrel
T07R9026A	1489.0	172.5	Island 28	LH2 Barrel
T07R9027A	2017.0	5.6	Island 33	LH2 Barrel
T07R9028A	2057.0	5.6	Island 35	LH2 Barrel
T07R9029A	2002.5	168.7	Island 32	LH2 Barrel
T07R9030A	2038.97	356.3	Island 34	LH2 Barrel
T07R9031A	2057.0	276.0	Island 36	LH2 Barrel
T07R9032A	2057.0	340.6	Island 37	LH2 Barrel
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2100.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2035.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

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Table 2.2 STS-2 ET INTERFERENCE FACTORS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9001	5029	1.180	1.122	1.048	1.646	1.836	1.952	2.235
9004	5031	0.991	1.000	0.997	0.988	0.925	0.916	0.911
9005	5030	0.947	0.938	0.914	0.984	0.928	0.930	0.897
9007	5033	0.957	0.888	0.858	0.869	0.774	0.795	0.835
9008	5032	1.120	1.156	1.127	1.170	1.135	1.124	1.026
9010	5034	0.459	0.424	0.367	0.351	0.343	0.293	0.316
9011	5042	1.603	1.619	1.798	1.708	1.583	1.623	1.617
9013	5041				4.290	2.996	3.236	4.471
9014	5038	3.474	3.223	3.367	3.724	3.992	5.099	5.874
9015	5258	6.505	8.366		9.567	9.592	10.803	12.326
9016	5036	5.242	5.412	6.619	5.167	4.839	5.191	5.185
9017	5035	0.620	0.642	0.635	0.760	0.709	0.720	0.742
9018	5039	3.424	4.219	4.053	3.809	2.587	2.544	3.687
9019	5040	3.095	3.533	3.277	2.833	2.177	1.797	2.546
9021	5043	0.112	0.277	0.397	0.513	1.339	1.379	1.404
9022	5044	1.320	1.078	0.624	0.688	0.650	0.642	0.719
9025	5046	1.045	1.056	1.395	1.487	1.526	0.961	0.963
9026	5045	0.645	0.707	0.725	0.941	1.000	1.088	0.759
9027	5048	1.298	1.806	2.440	2.134	2.237	2.109	1.426
9028	5050	1.080	1.439	1.842	2.153	2.729	2.646	2.276
9029	5047	0.545	0.392	0.454	0.462	0.464	0.367	0.249
9030	5049	3.084	3.729	1.510	1.428	3.341	2.646	3.507
9031	5051	2.615	3.656	4.091	2.888	1.854	1.882	6.903
9032	5052	2.440	2.961	2.600	2.255	2.345	2.255	3.076

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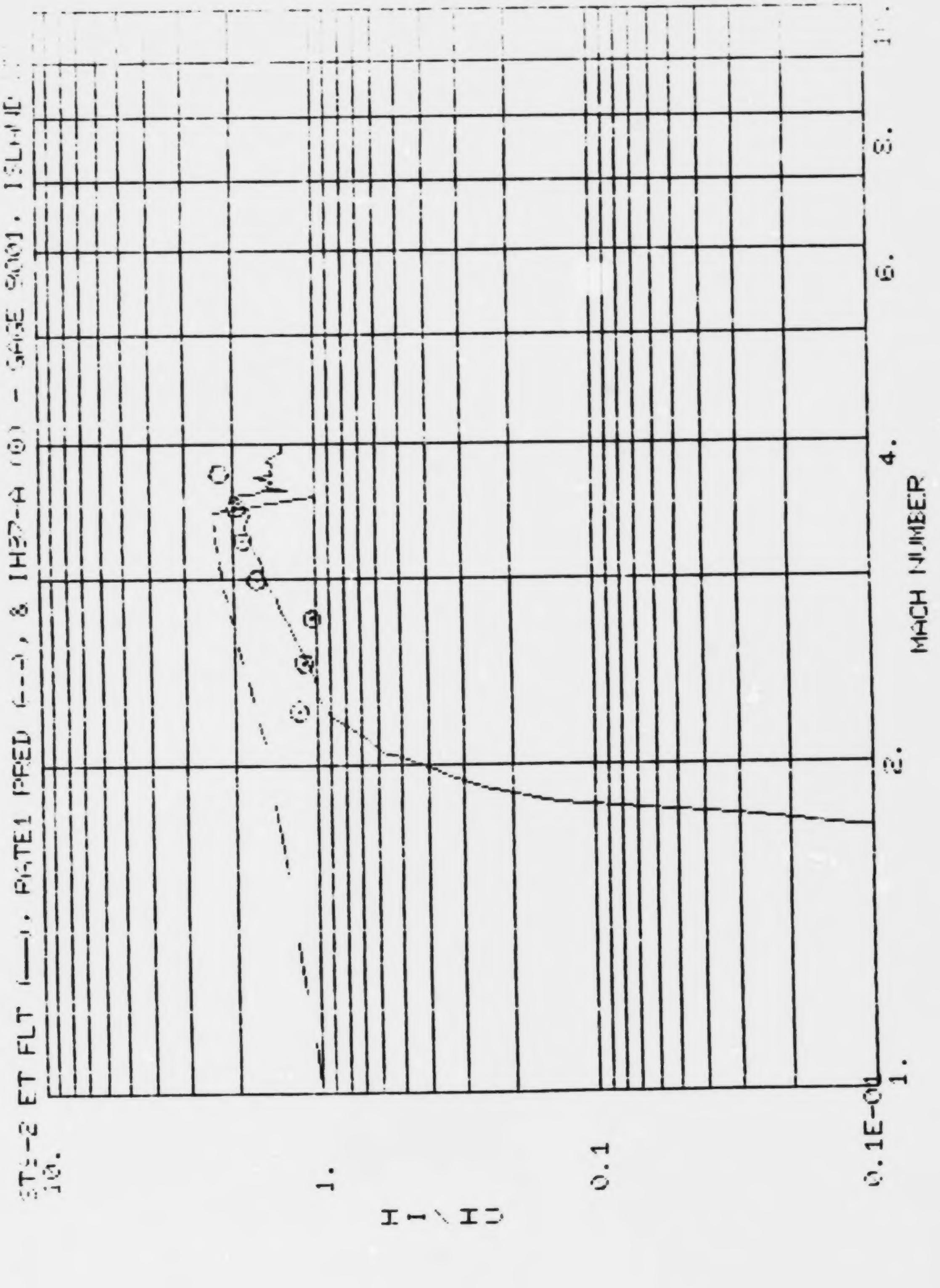

Fig. 2.1

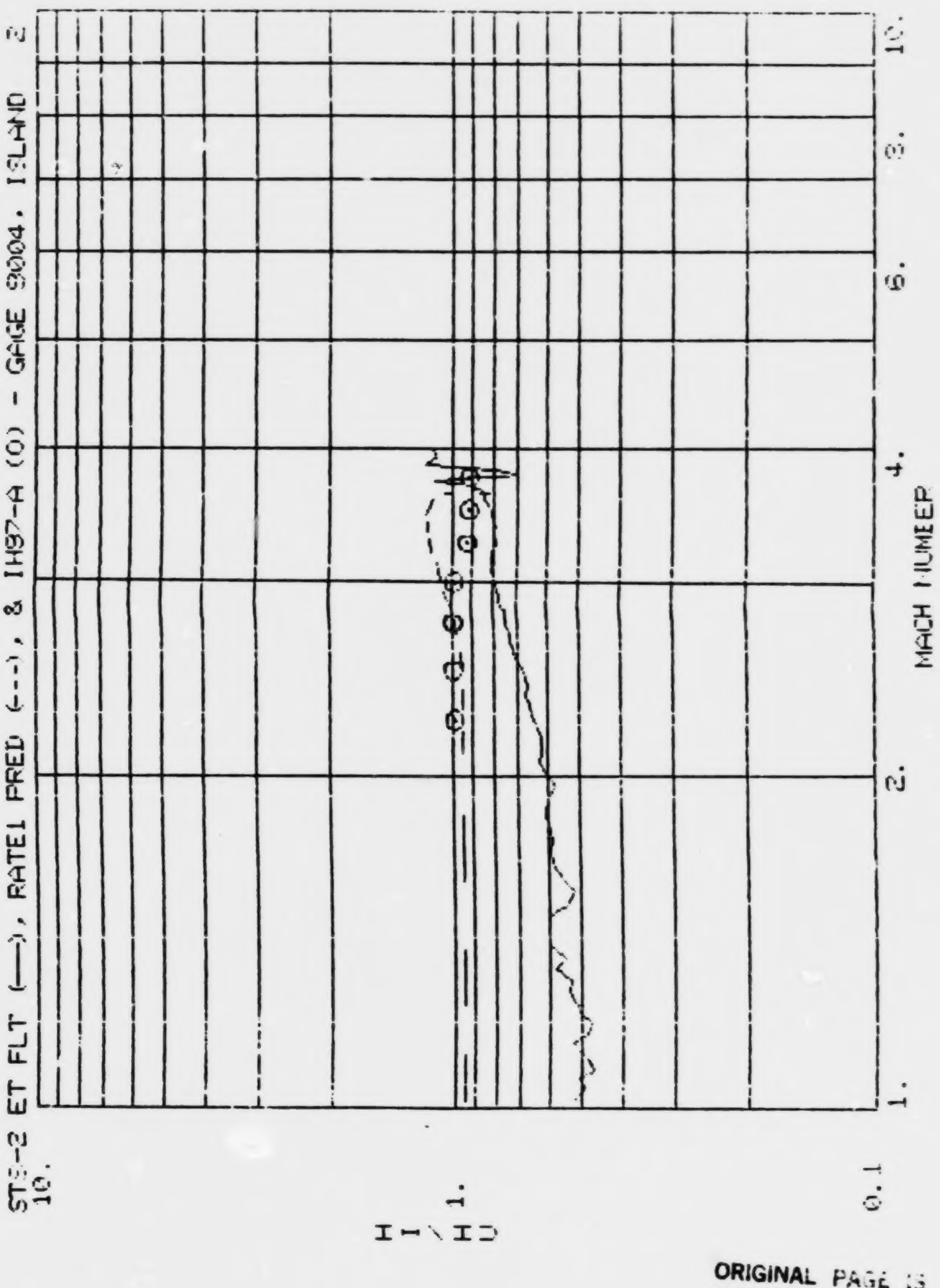

Fig. 2.2

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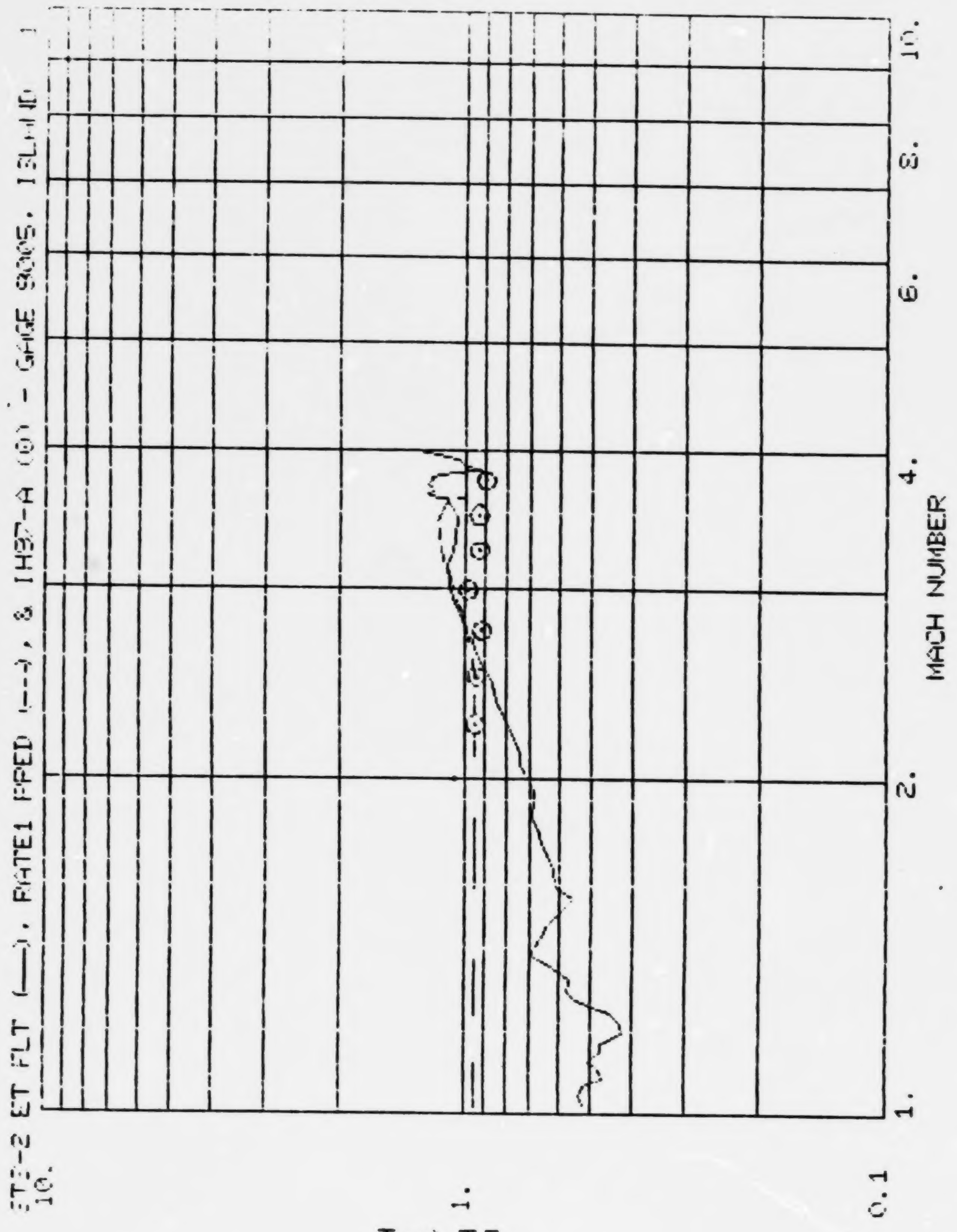
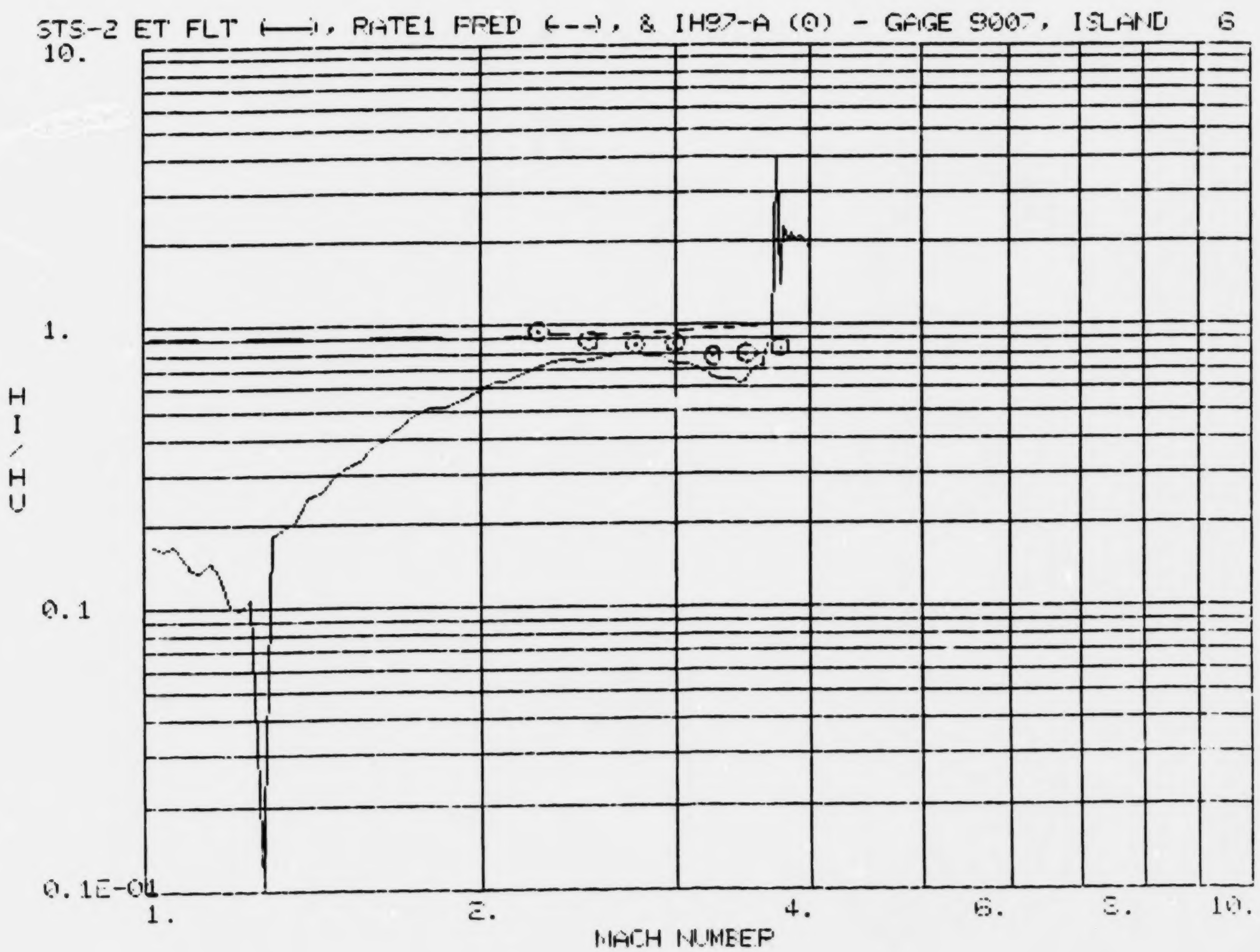


Fig. 2.3


STS-2 ET FLT (——), RATE1 FRED (--), & IH97-A (⊙) - GAGE 9007, ISLAND 6
10.
1.
0.1
0.1E-01
HI/HU
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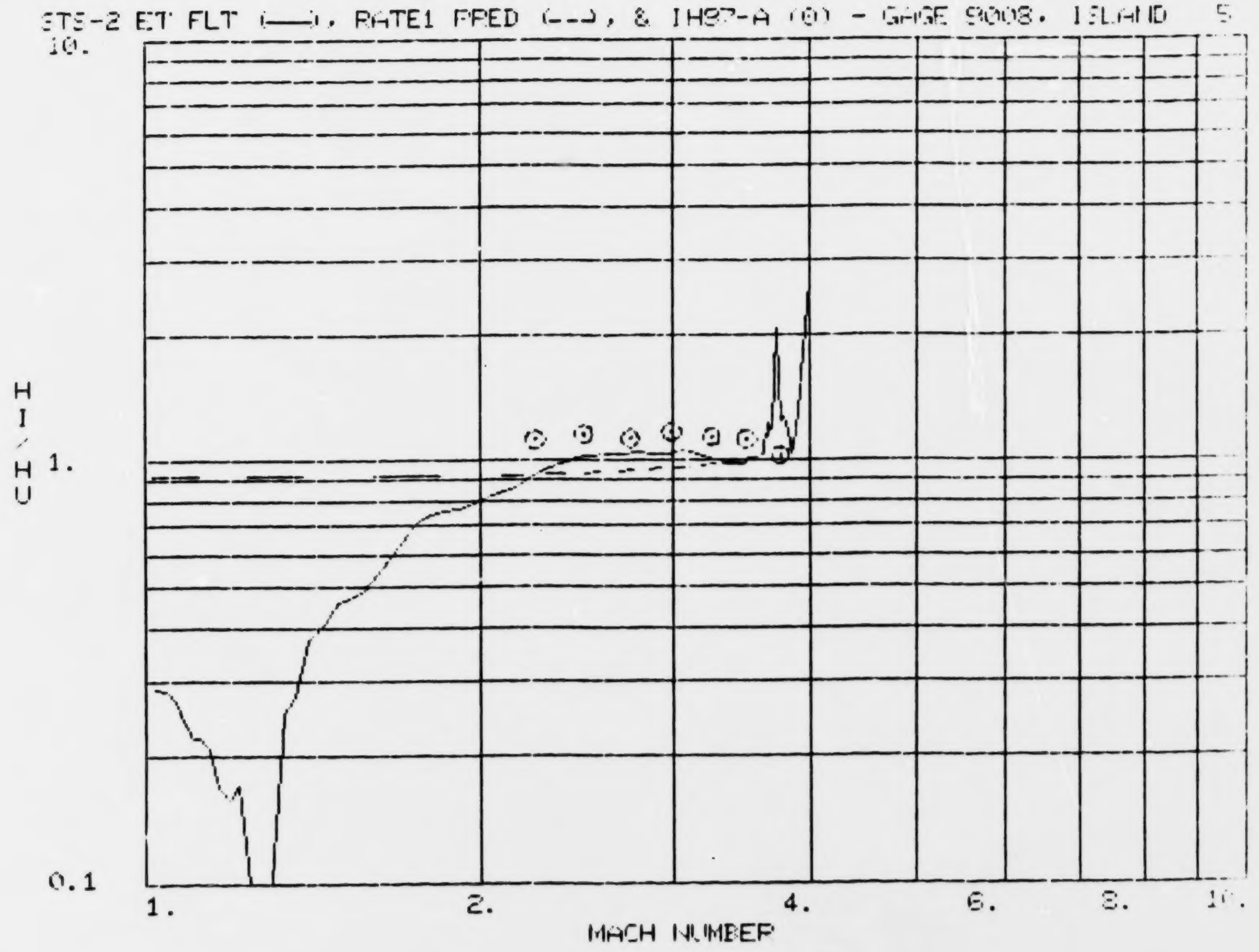
MACH NUMBER

Fig. 2.4



STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9008. ISLAND 5
10.
1.
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HI/HU
1.
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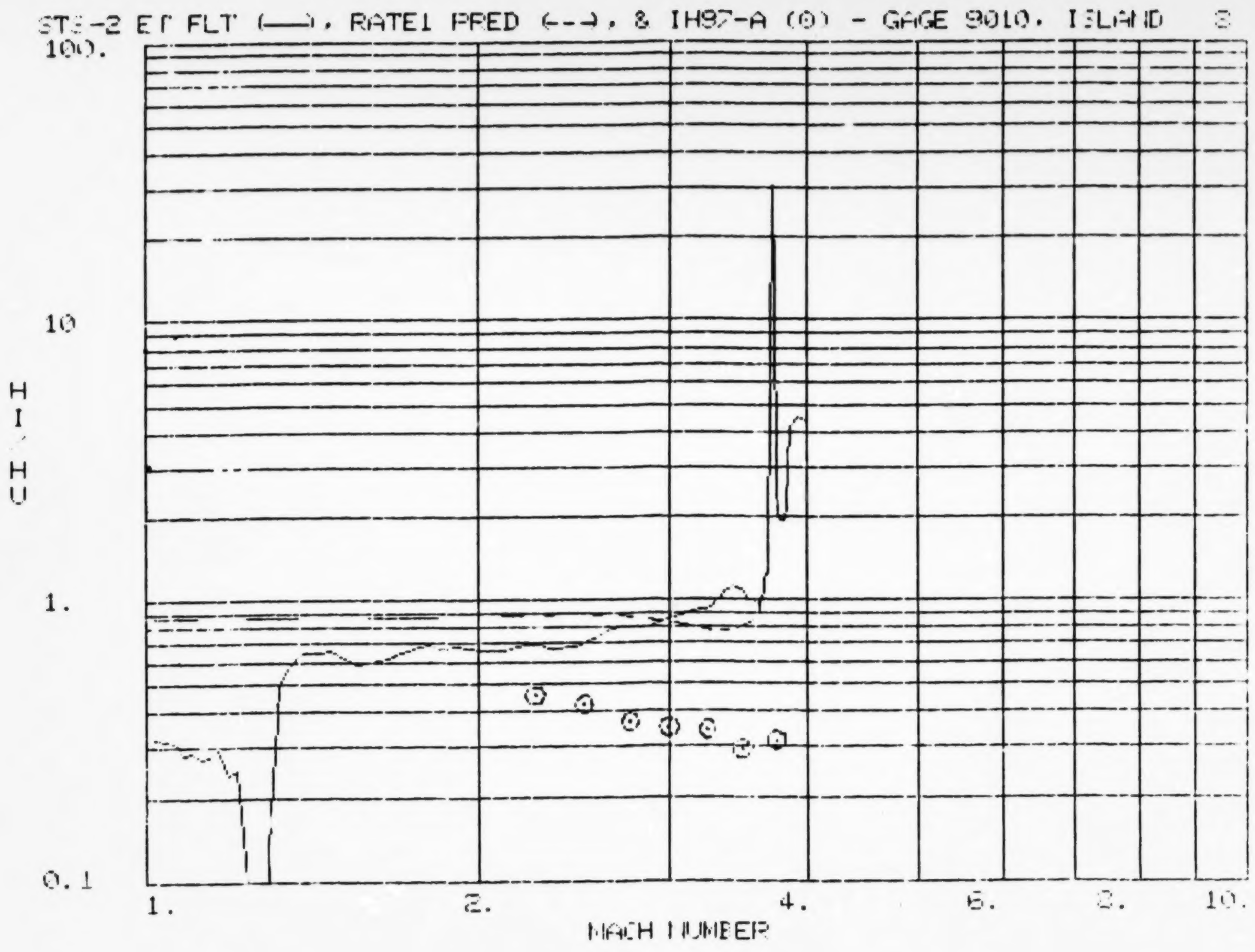
MACH NUMBER

Fig. 2.5


STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9010, ISLAND
100.
10
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H I / H U
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MACH NUMBER

Fig. 2.6

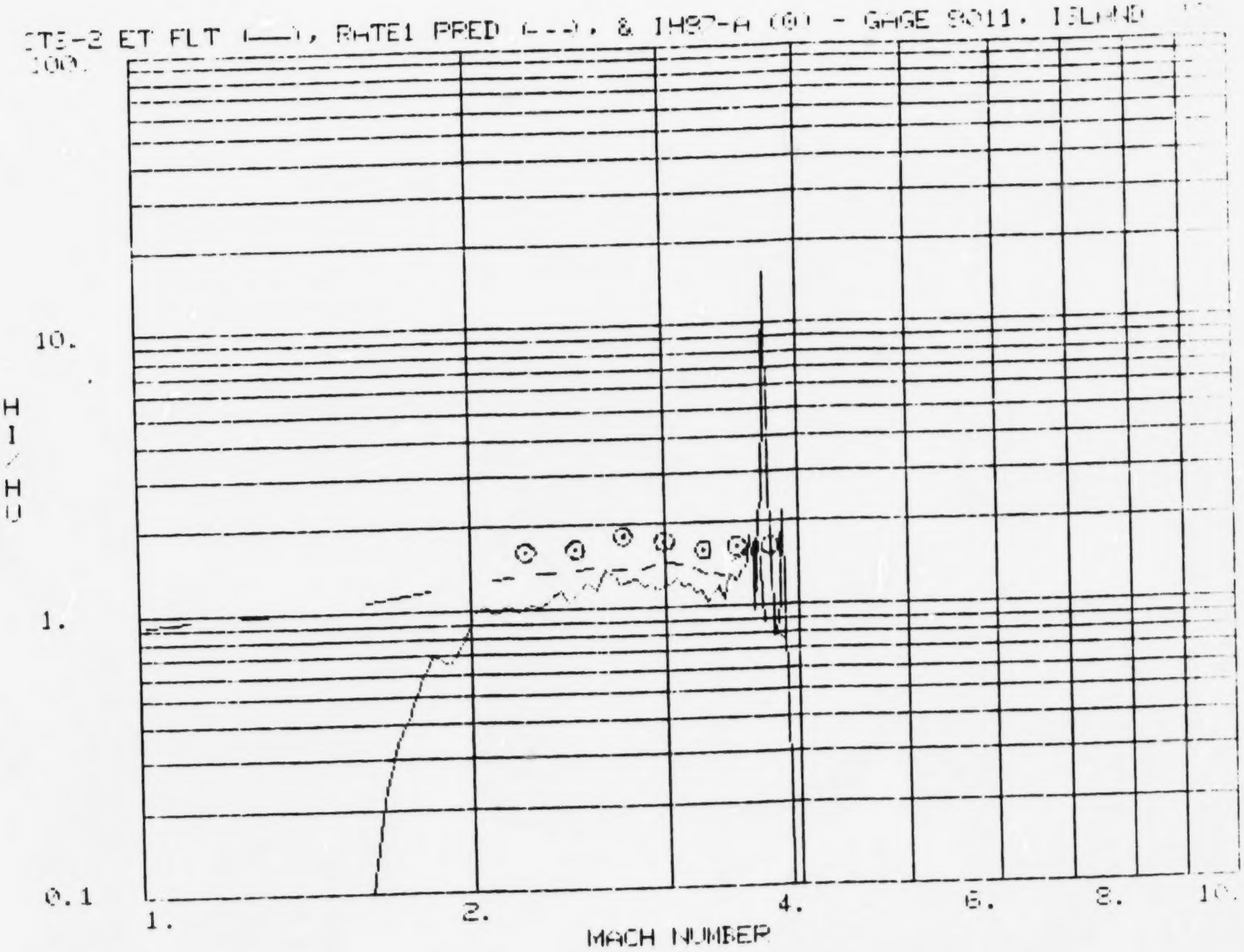

Fig. 2.7

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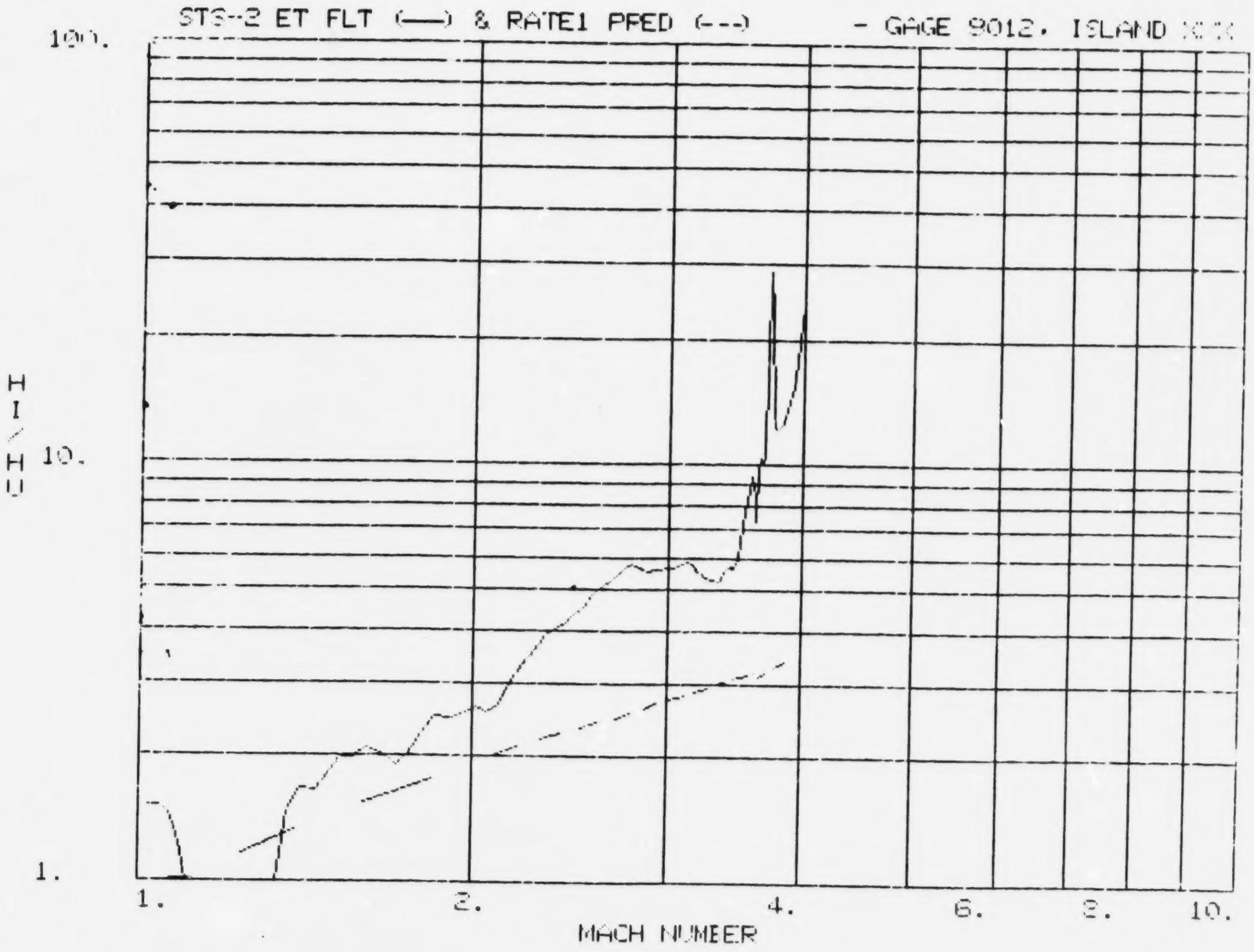

STS-2 ET FLT (——) & RATE1 PRED (- - -) - GAGE 9012, ISLAND
100.
10.
1.
H/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 2.8

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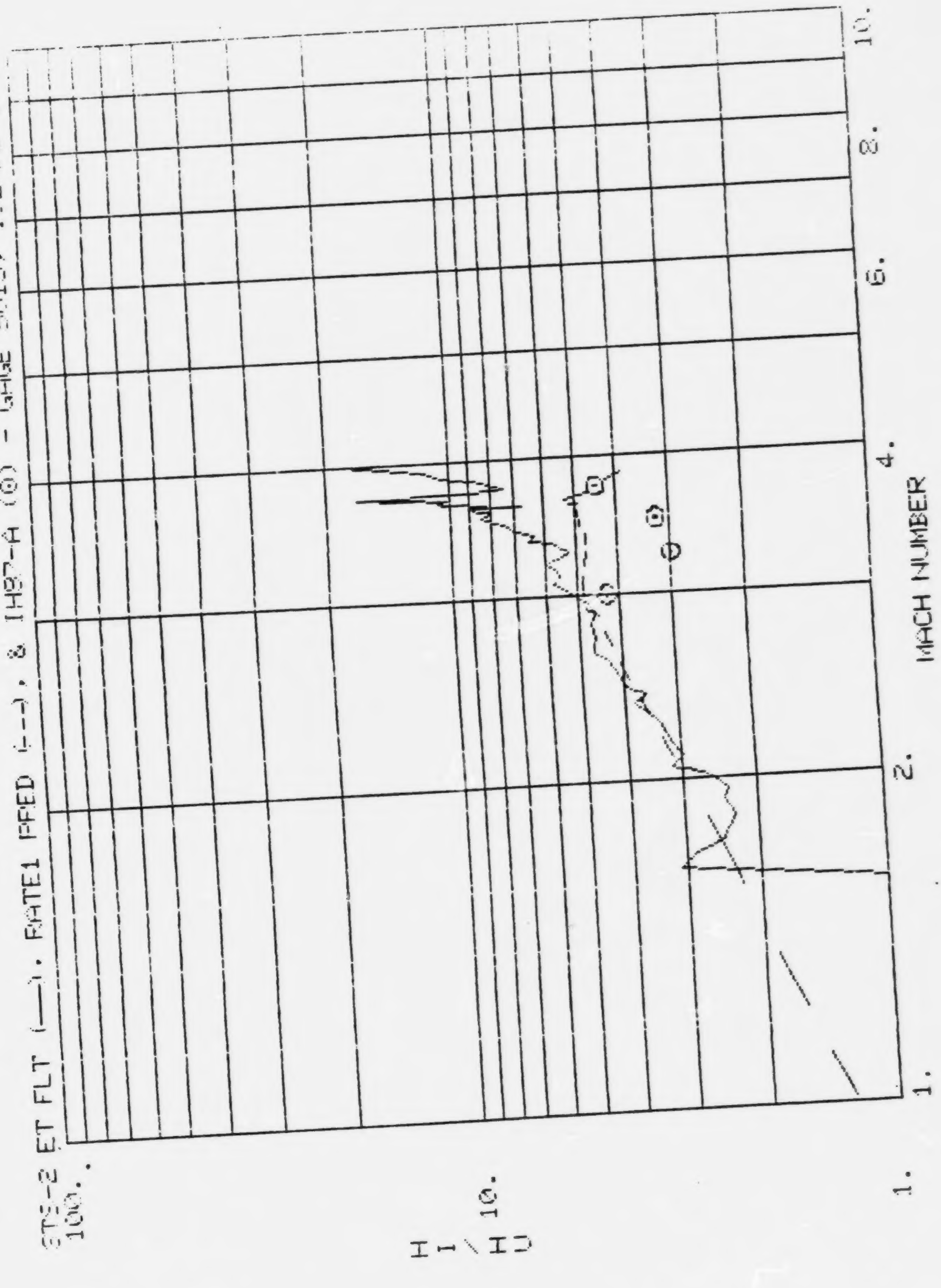
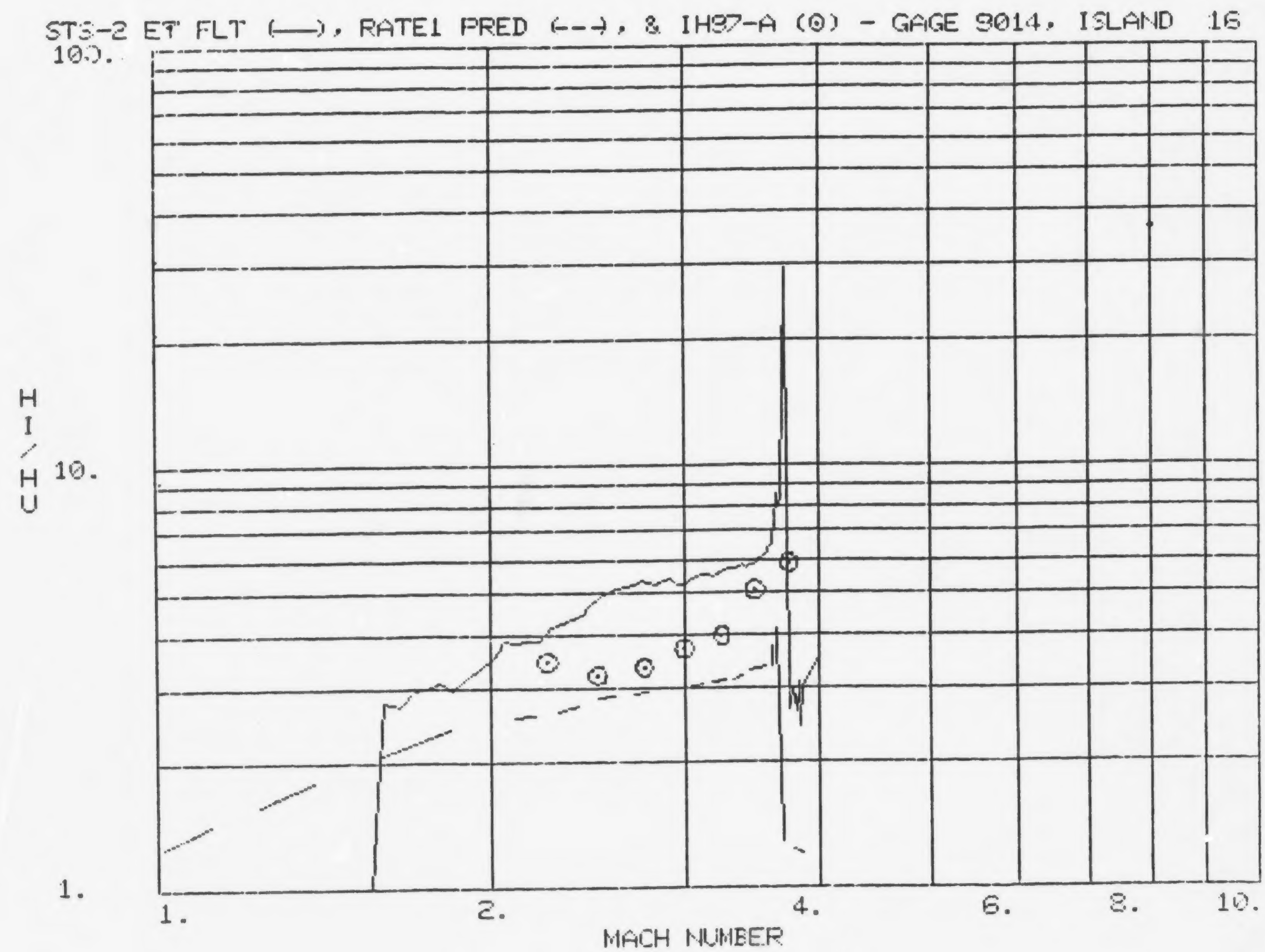


Fig. 2.9


STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9014, ISLAND 16
100.
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4.
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8.
10.
MACH NUMBER

Fig. 2.10

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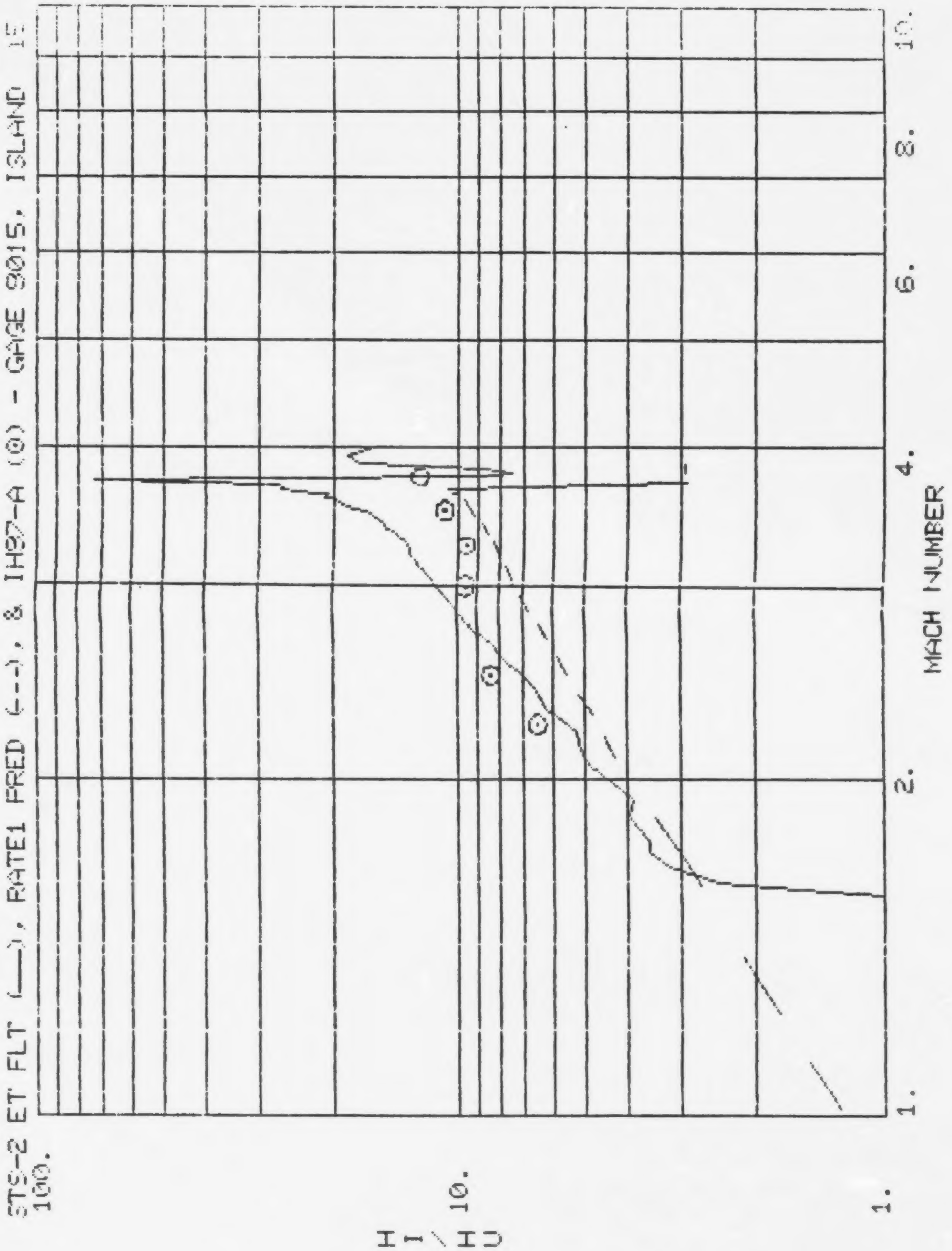
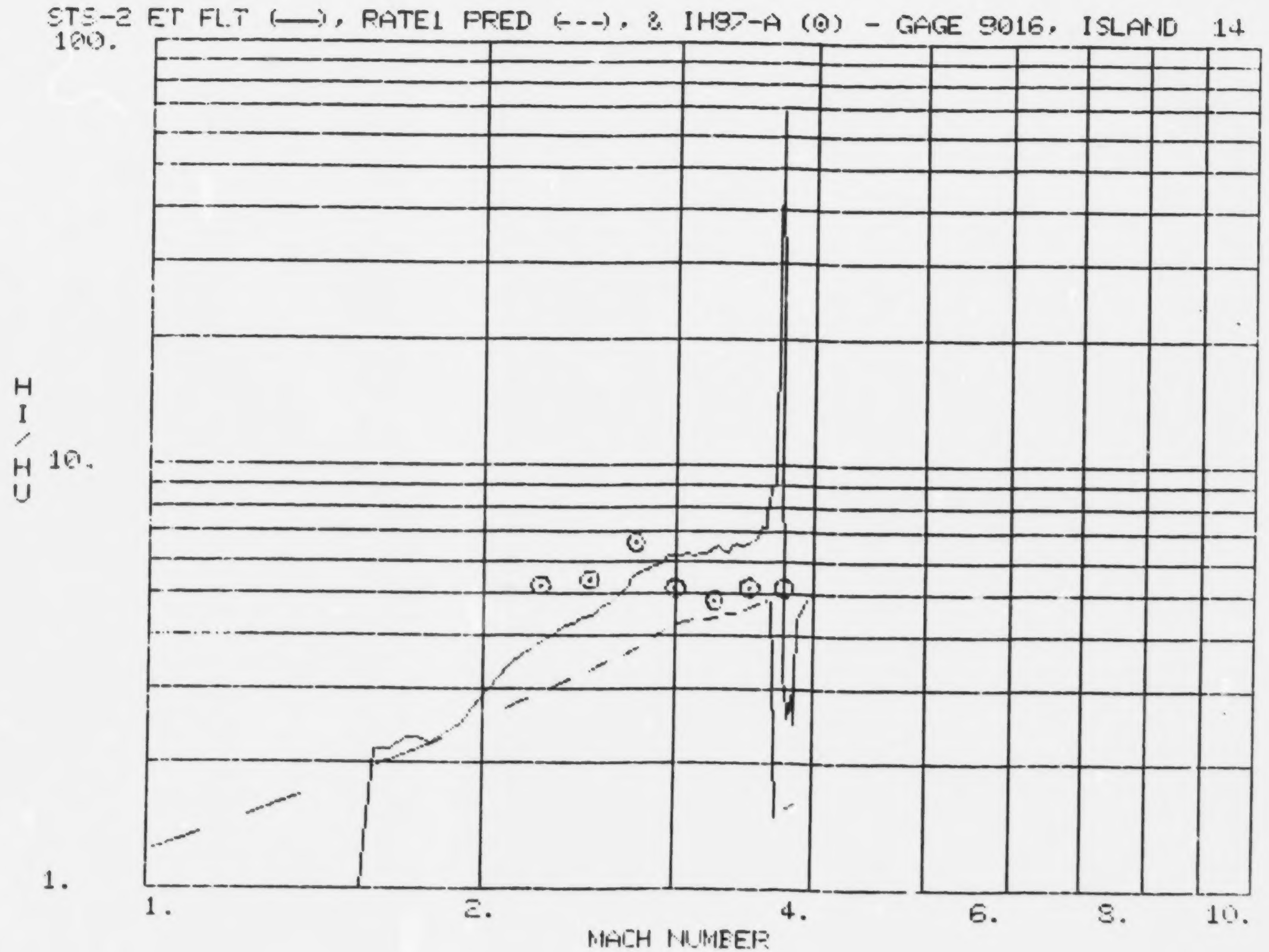


Fig. 2.11



STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9016, ISLAND 14
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Fig. 2.12

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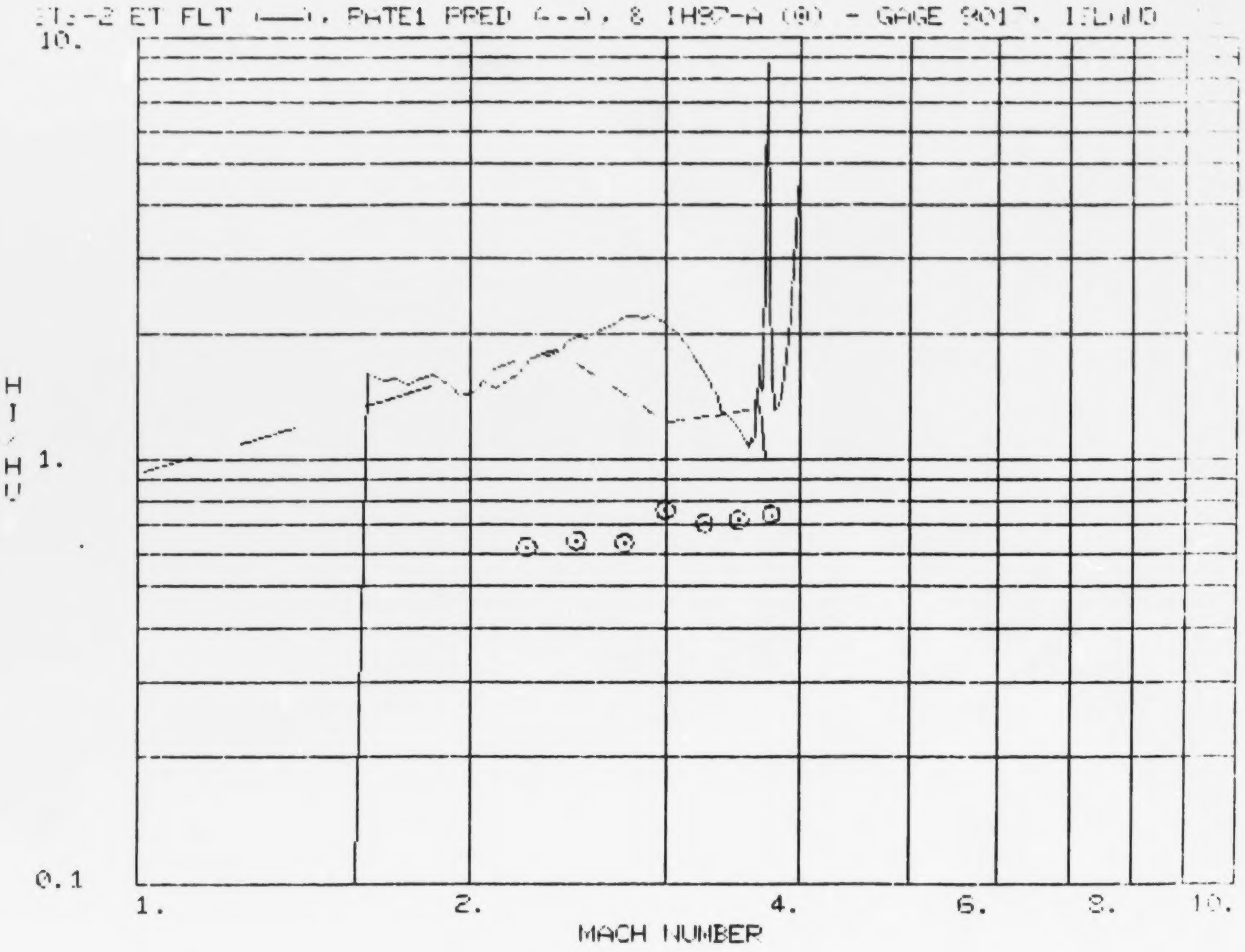

Fig. 2.13

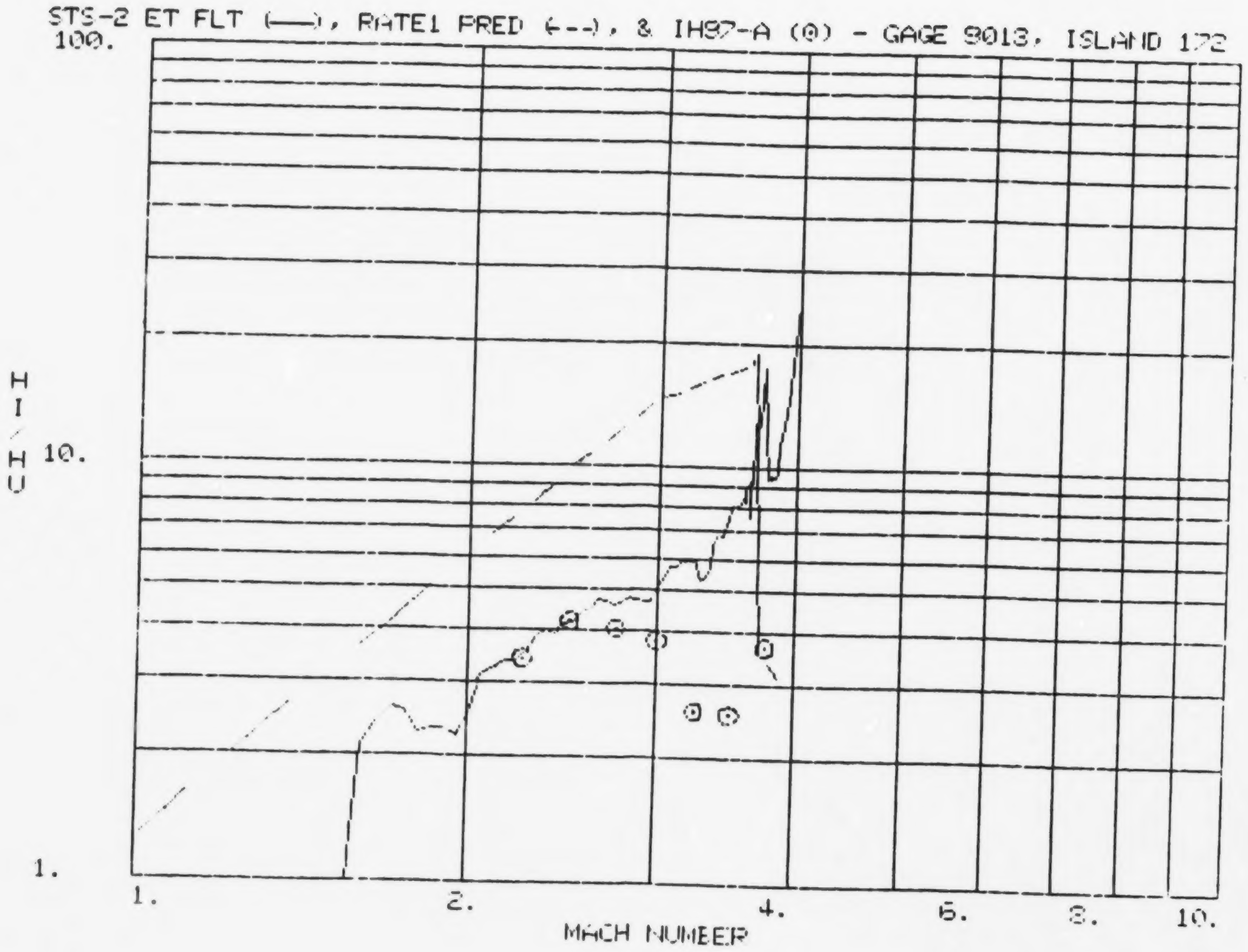
STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9013, ISLAND 172
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Fig. 2.14

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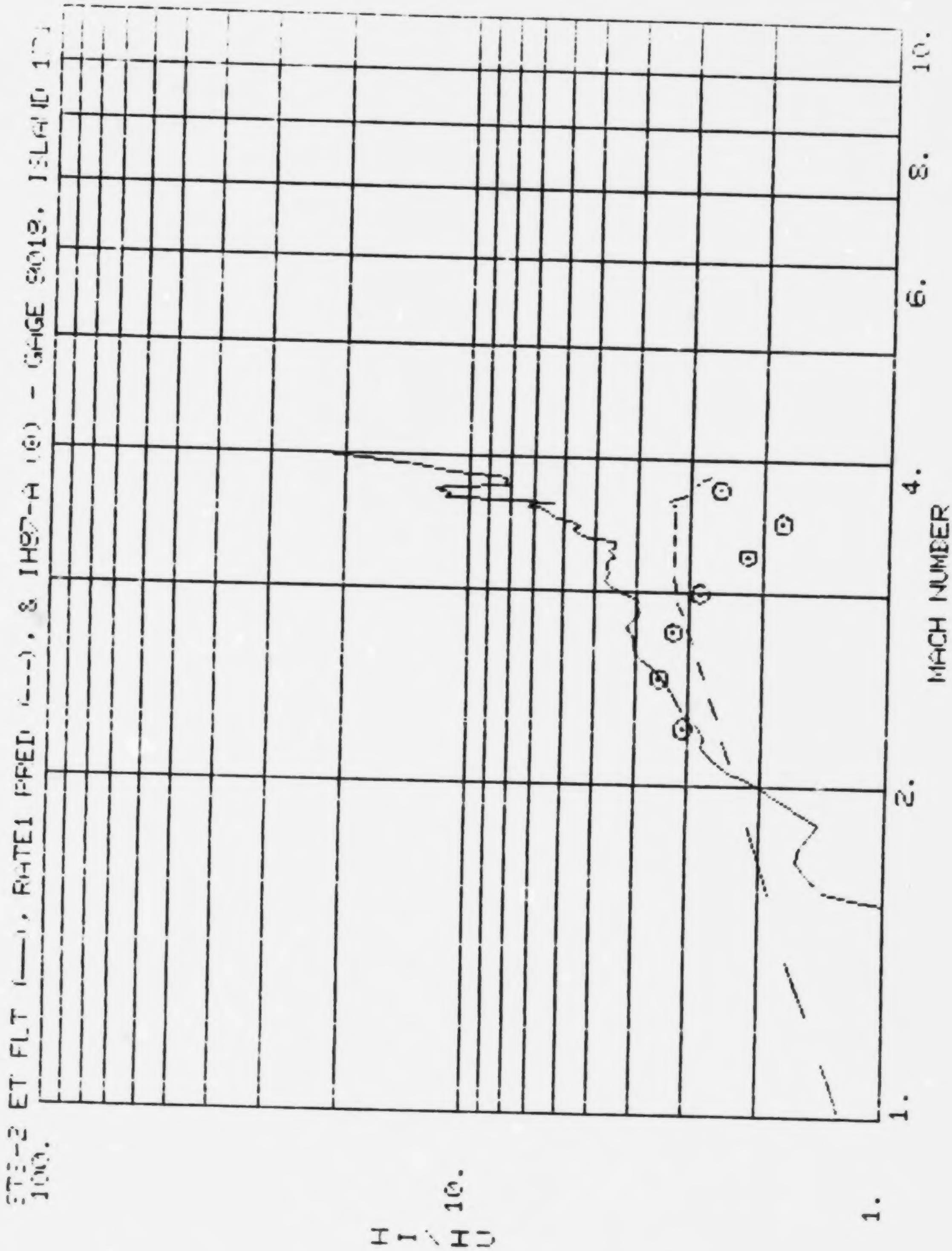
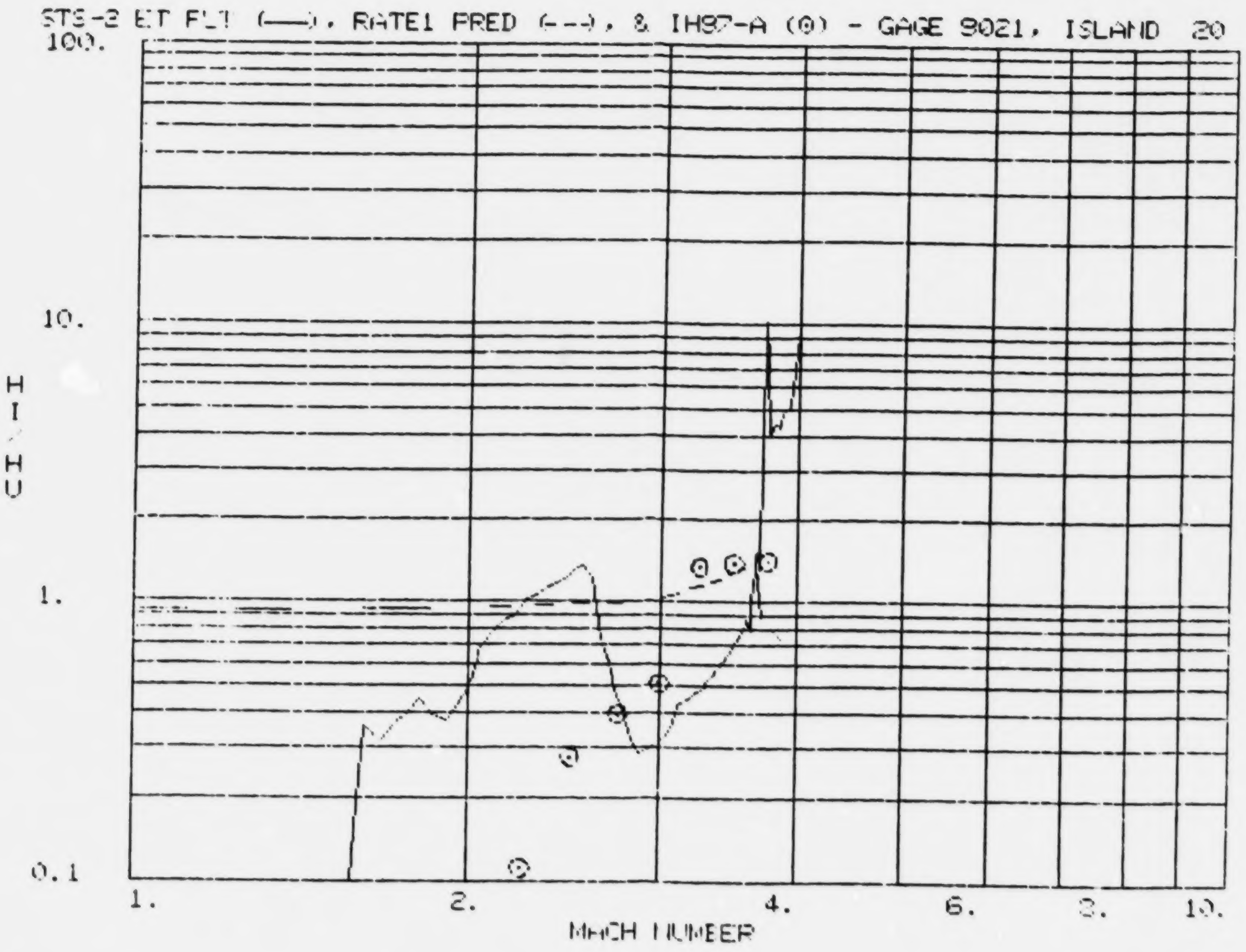


Fig. 2.15



STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9021, ISLAND 20
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Fig. 2.16

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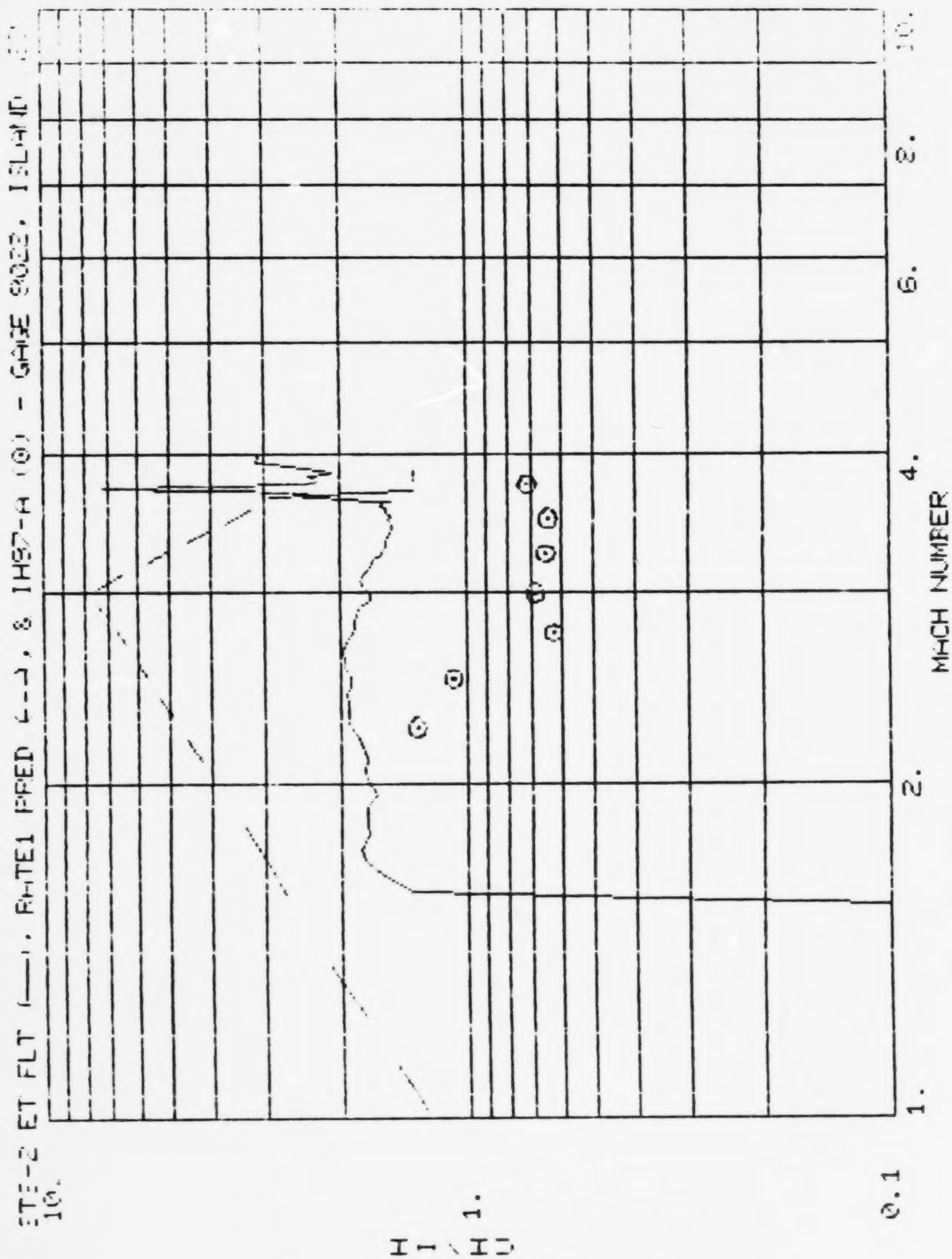

Fig. 2.17

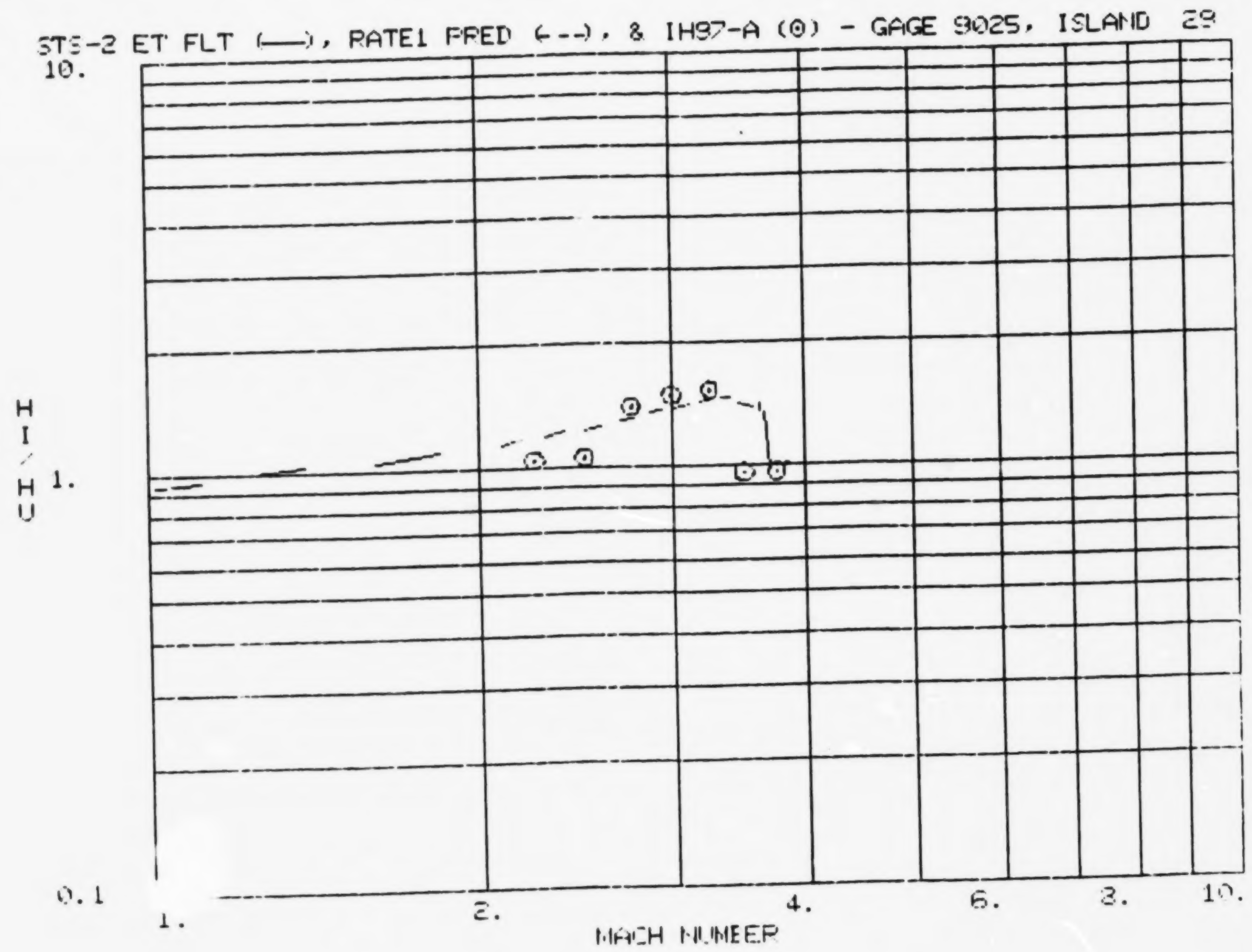

Fig. 2.18

NOTE: Bad Flight Data

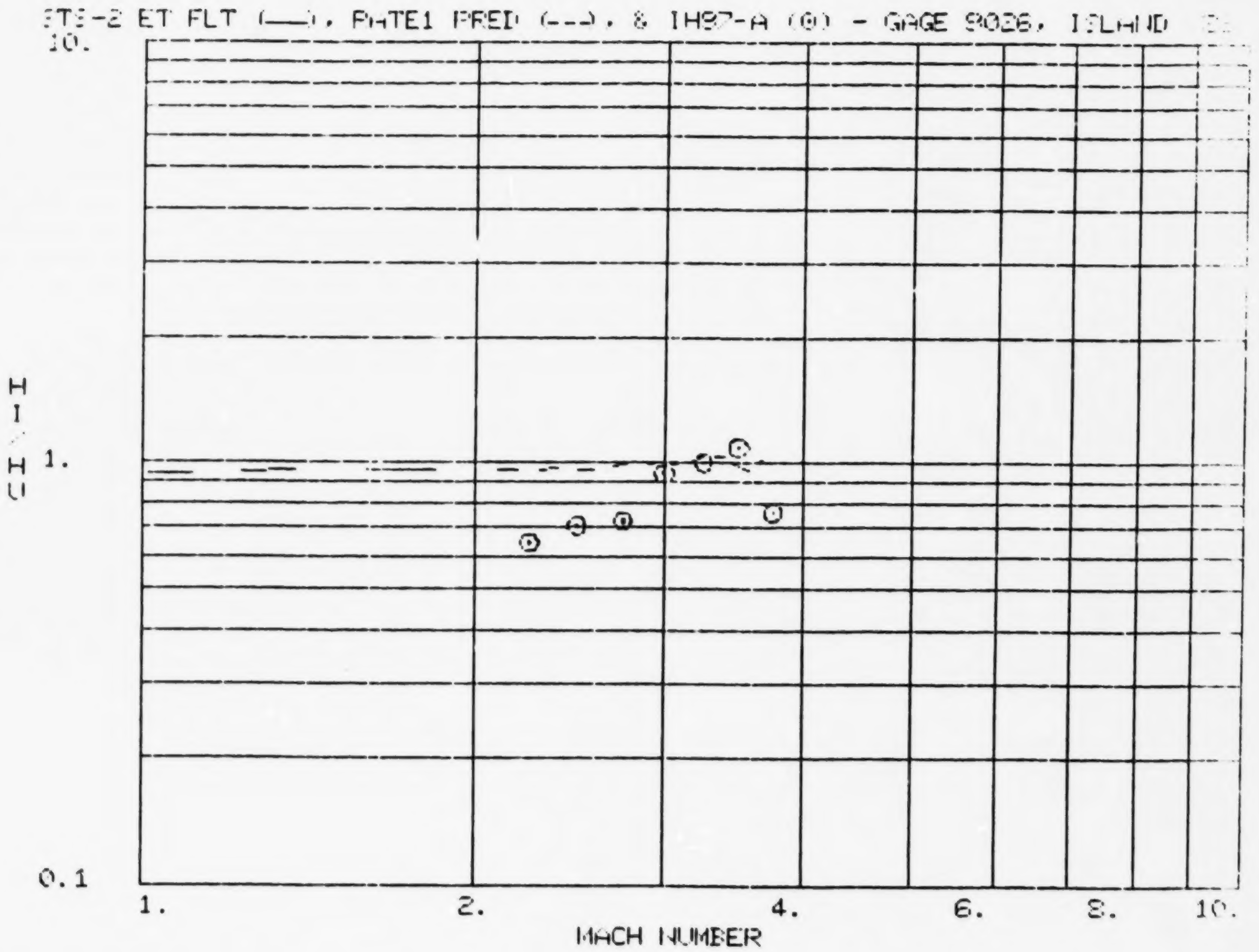

Fig. 2.19

NOTE: Bad Flight Data

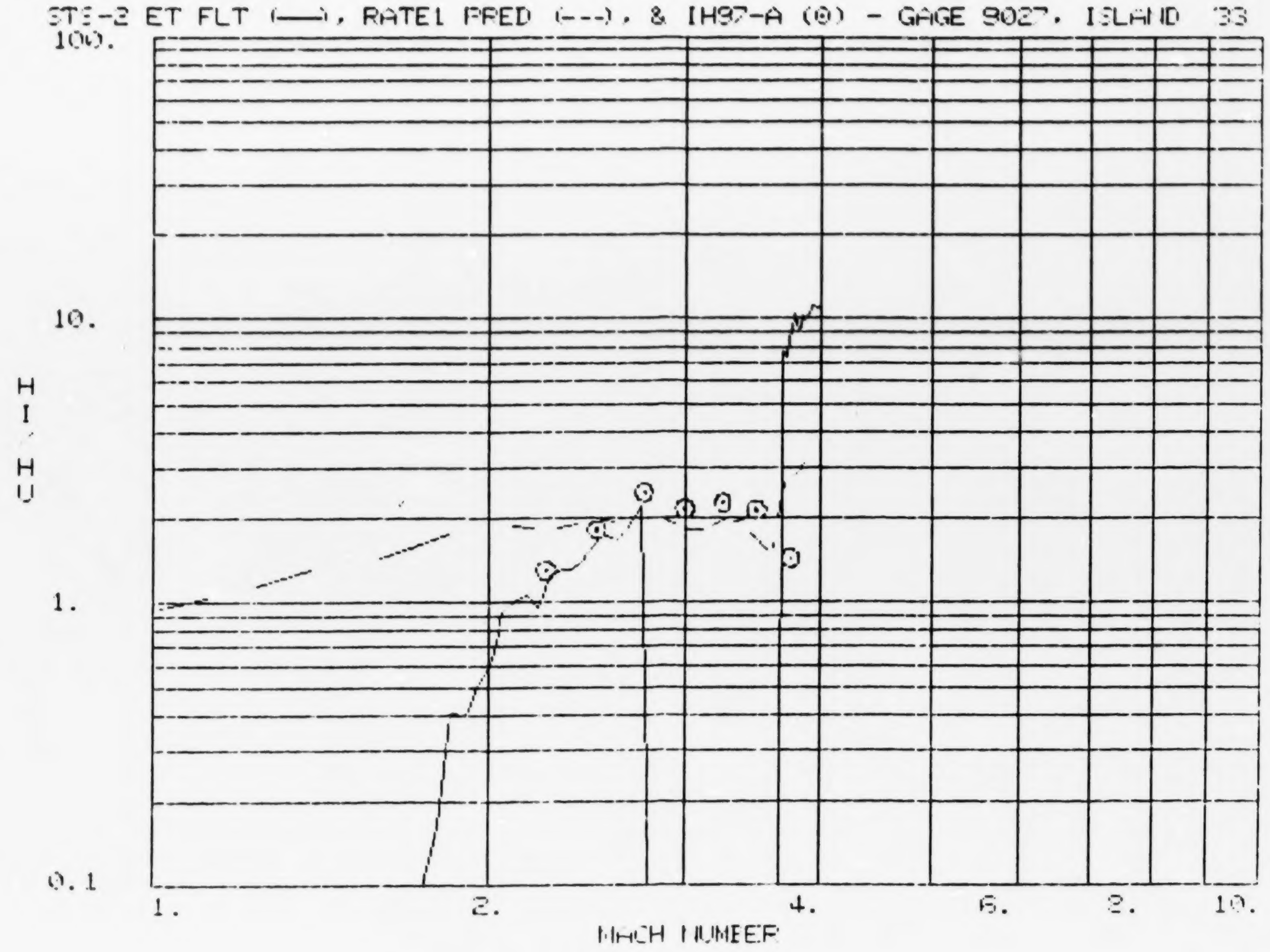
STS-2 ET FLT (——), RATE1 PRED (---), & IH97-A (⊙) - GAGE 9027, ISLAND 33
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Fig. 2.20

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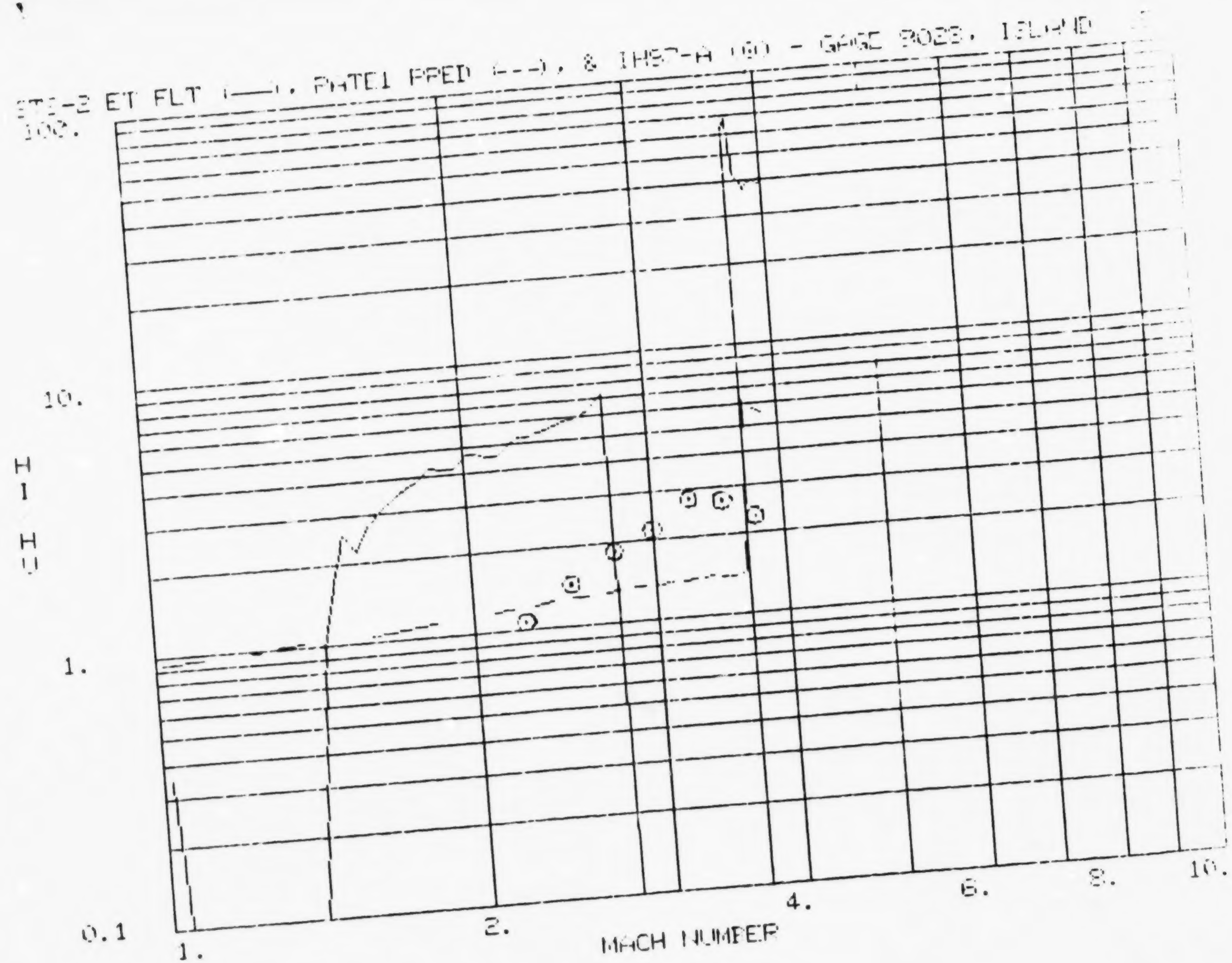
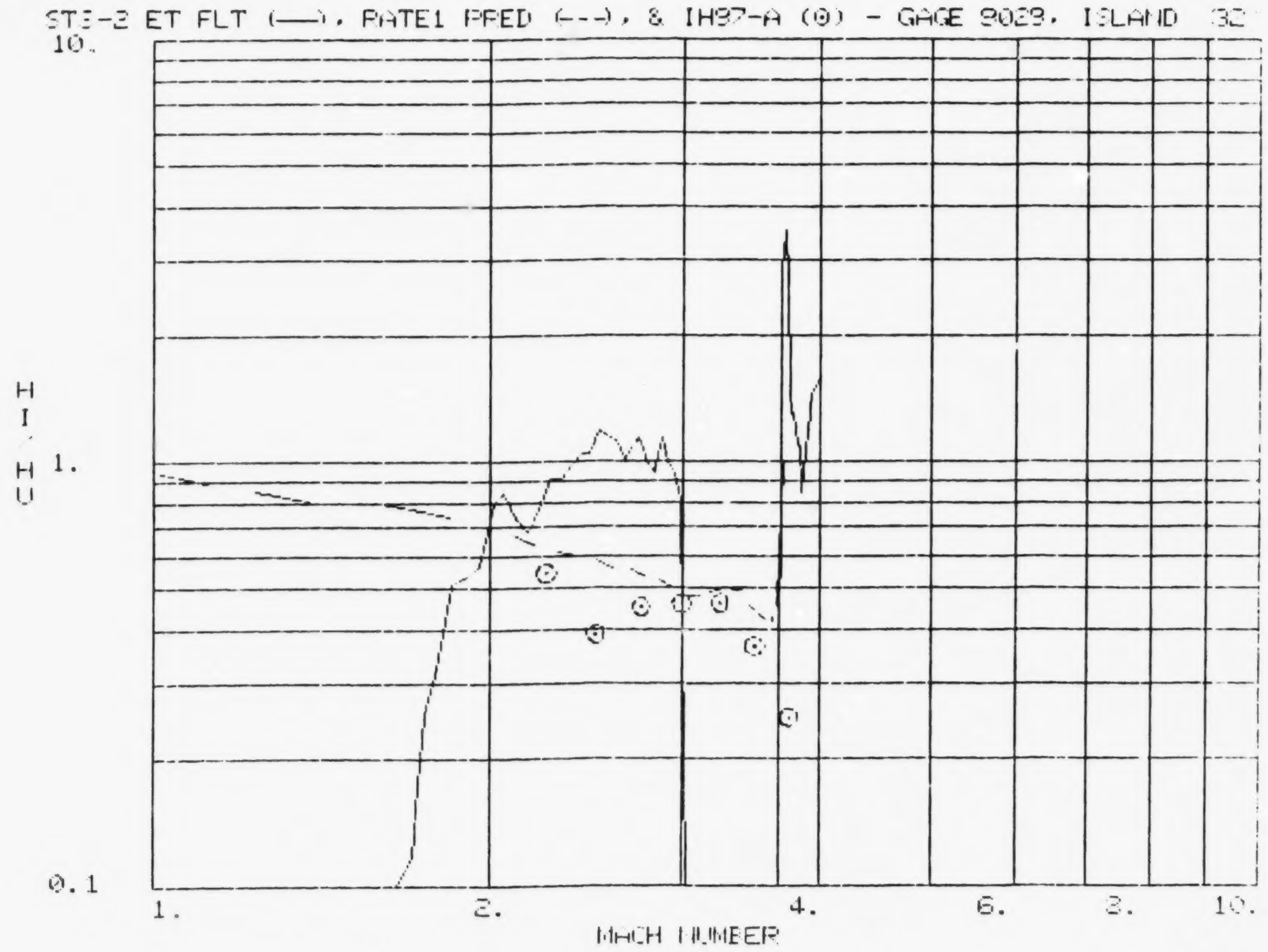


Fig. 2.21



STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 8023, ISLAND 32
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Fig. 2.22

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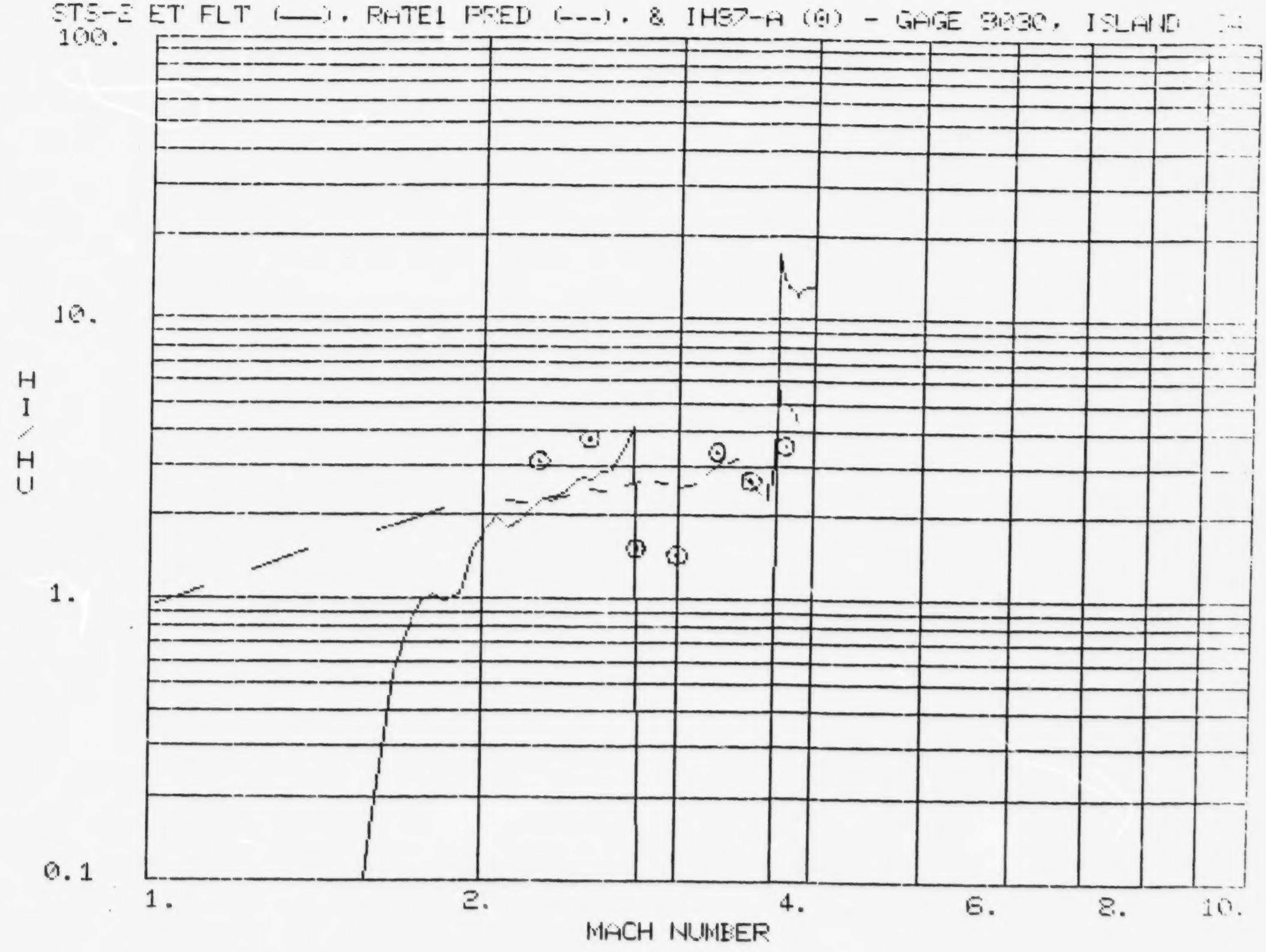

Fig. 2.23

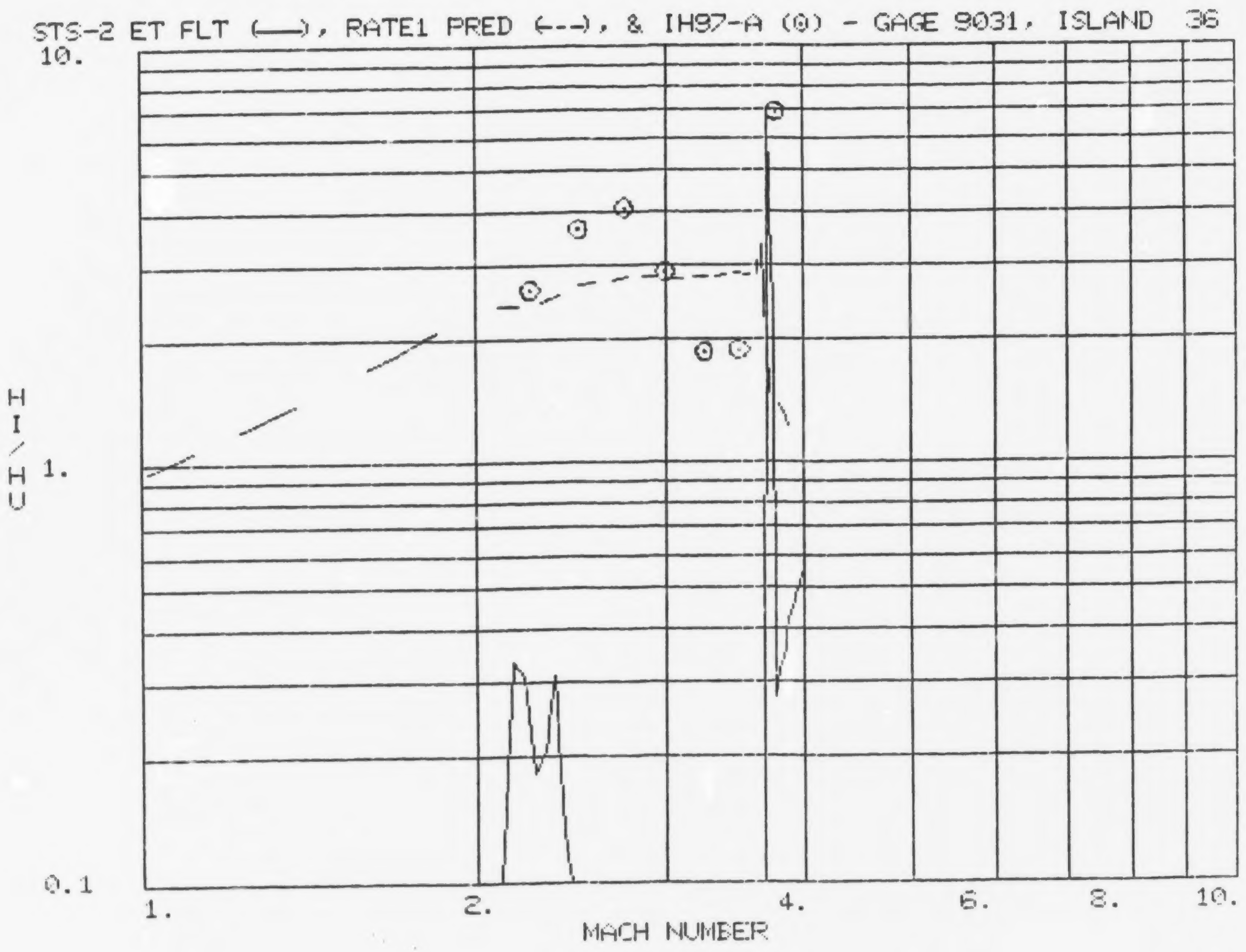
STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9031, ISLAND 36
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Fig. 2.24

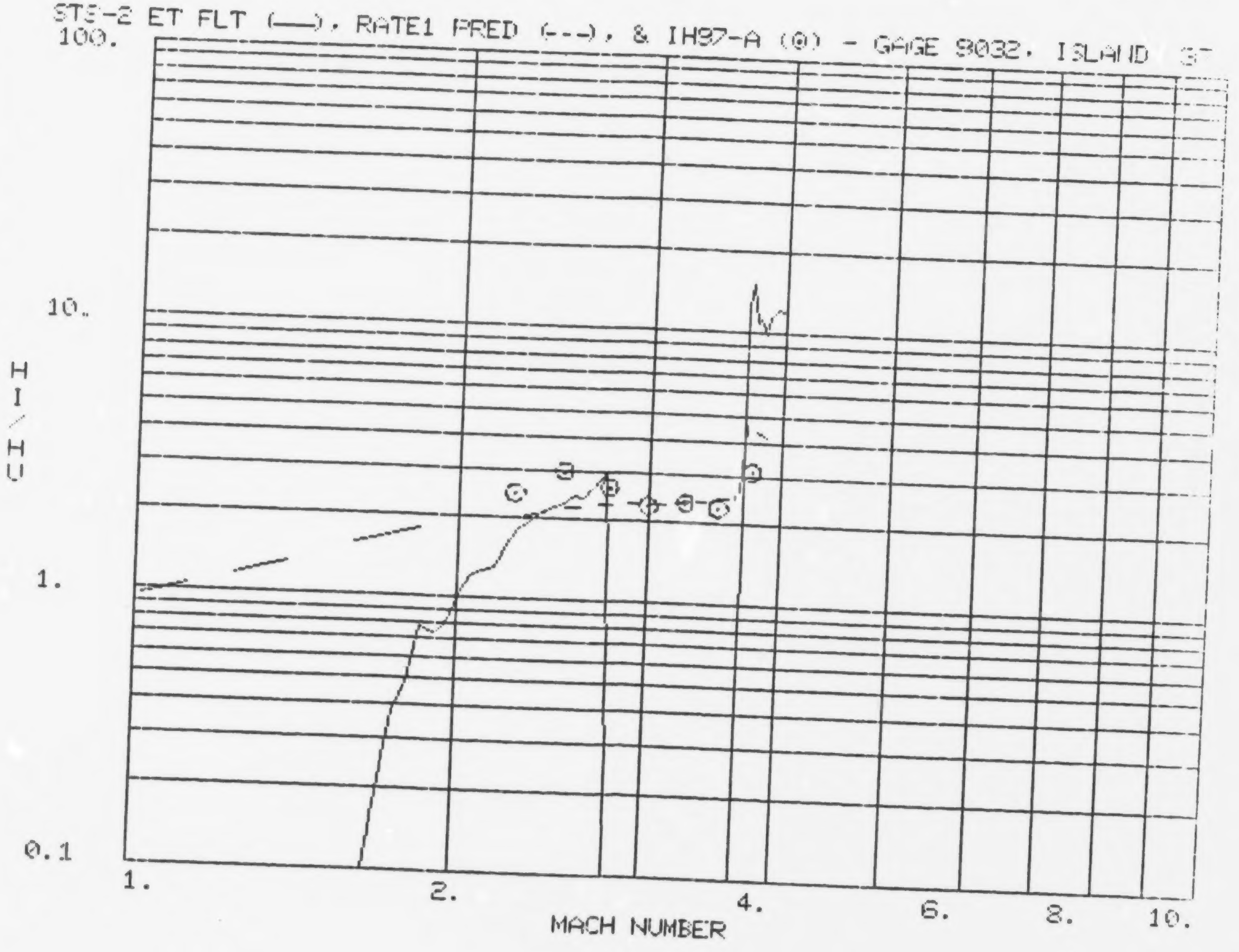
STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9032, ISLAND 37
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Fig. 2.25

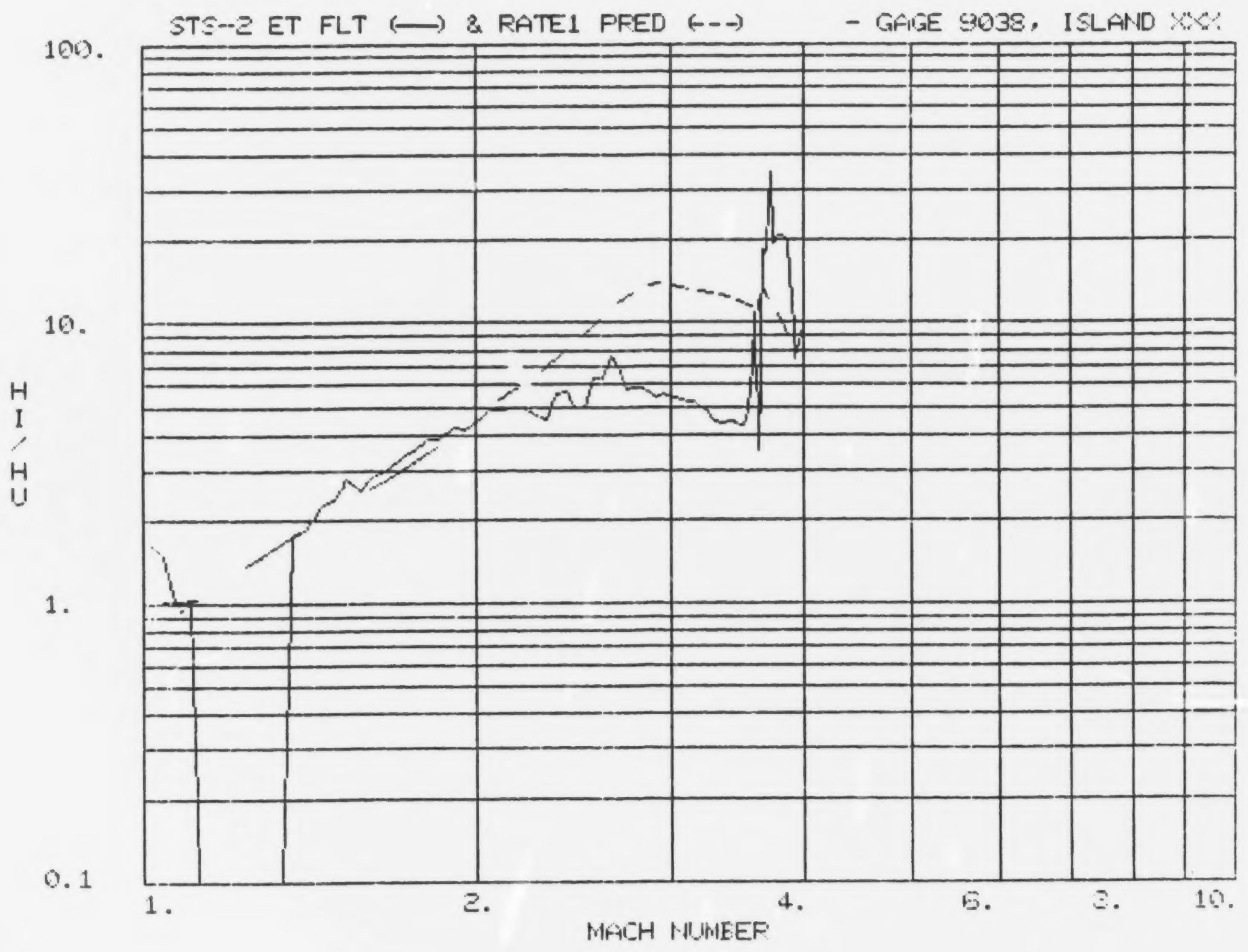
STS-2 ET FLT (——) & RATE1 PRED (- - -) - GAGE 9038, ISLAND XXX
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Fig. 2.26

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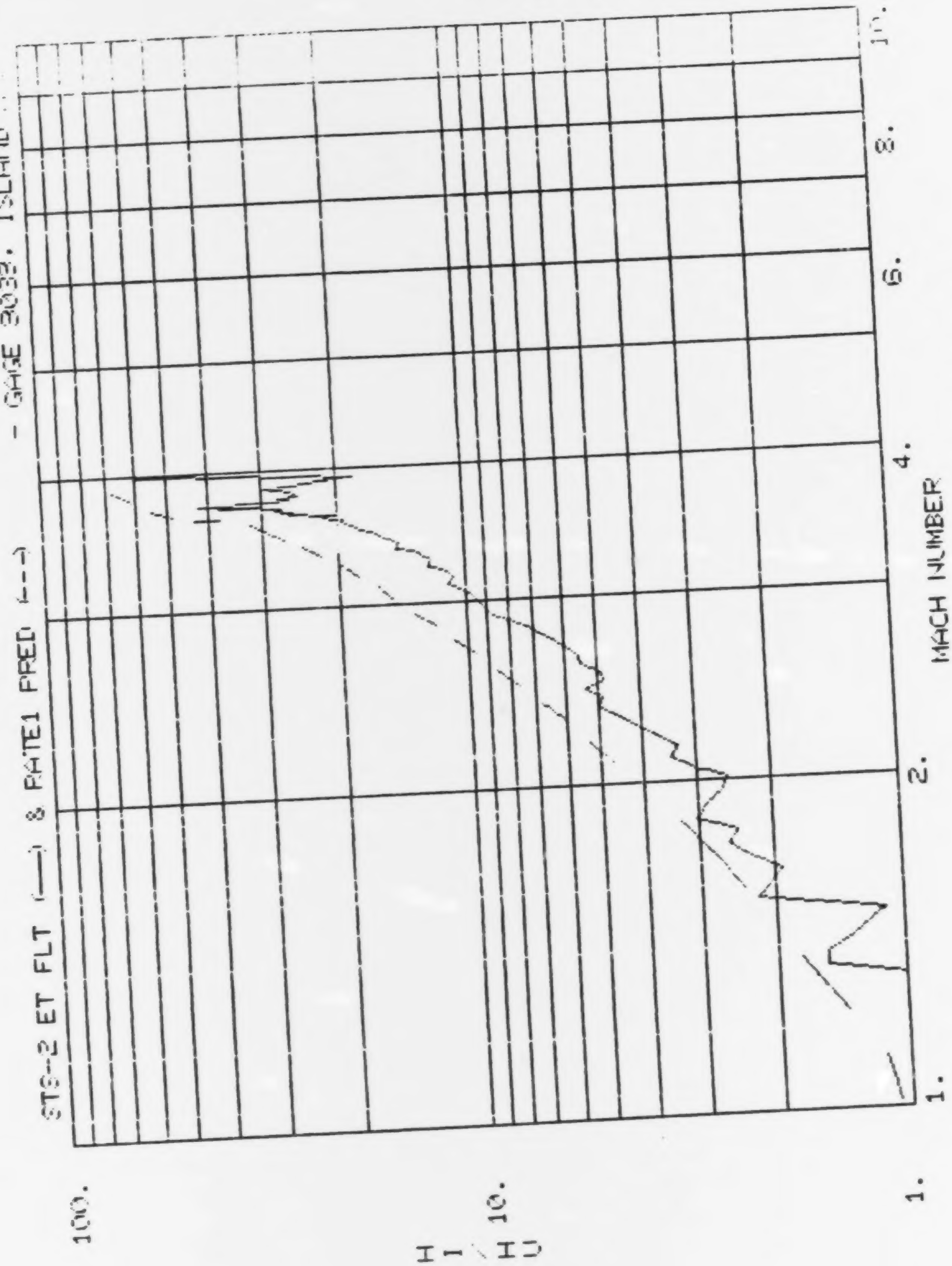

Fig. 2.27

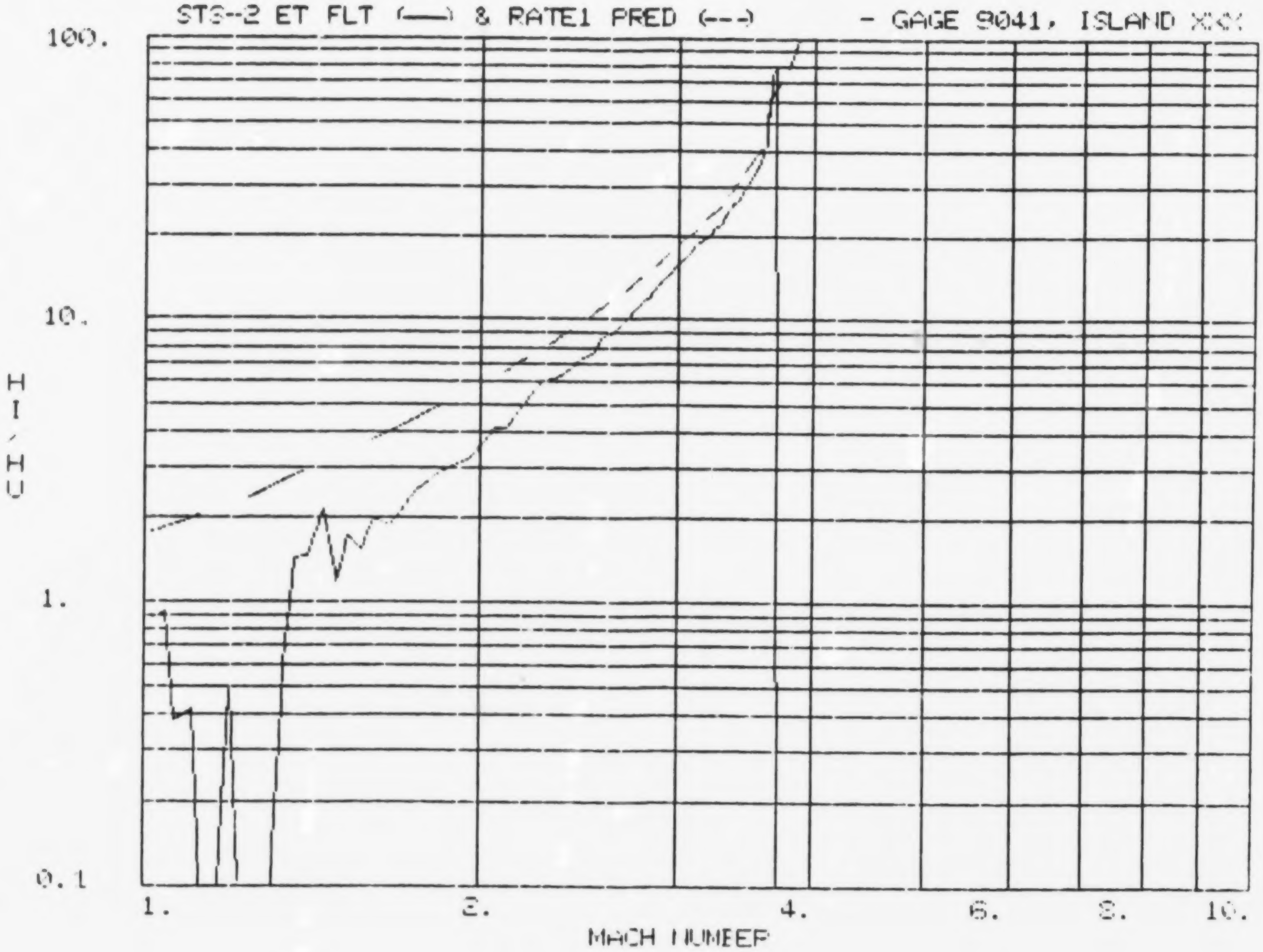
STS-2 ET FLT (——) & RATE1 PRED (-–-) - GAGE 9041, ISLAND XXX
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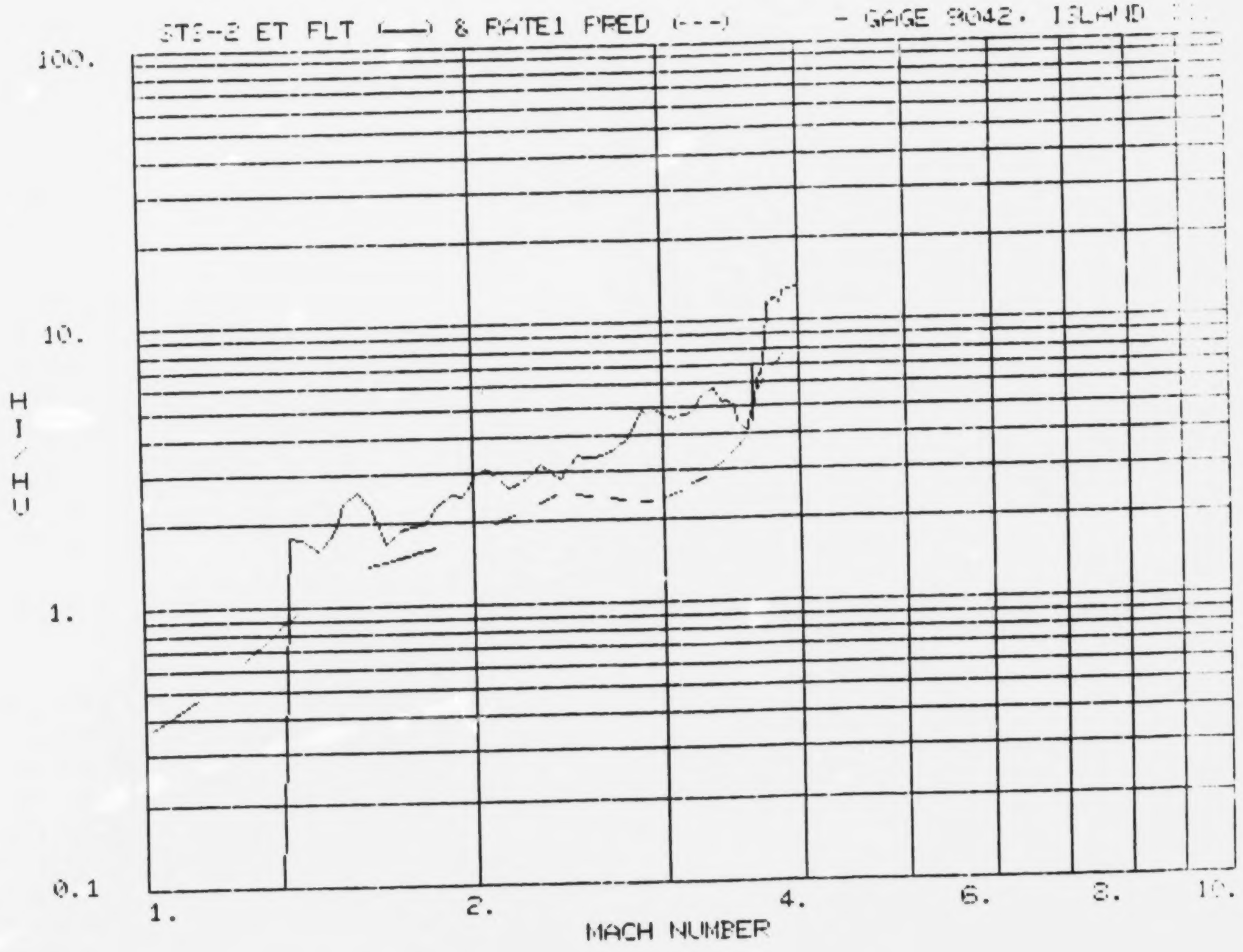
Fig. 2.28



STS-2 ET FLT (——) & RATE1 PRED (- - -) - GAGE 9042. ISLAND
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Fig. 2.29

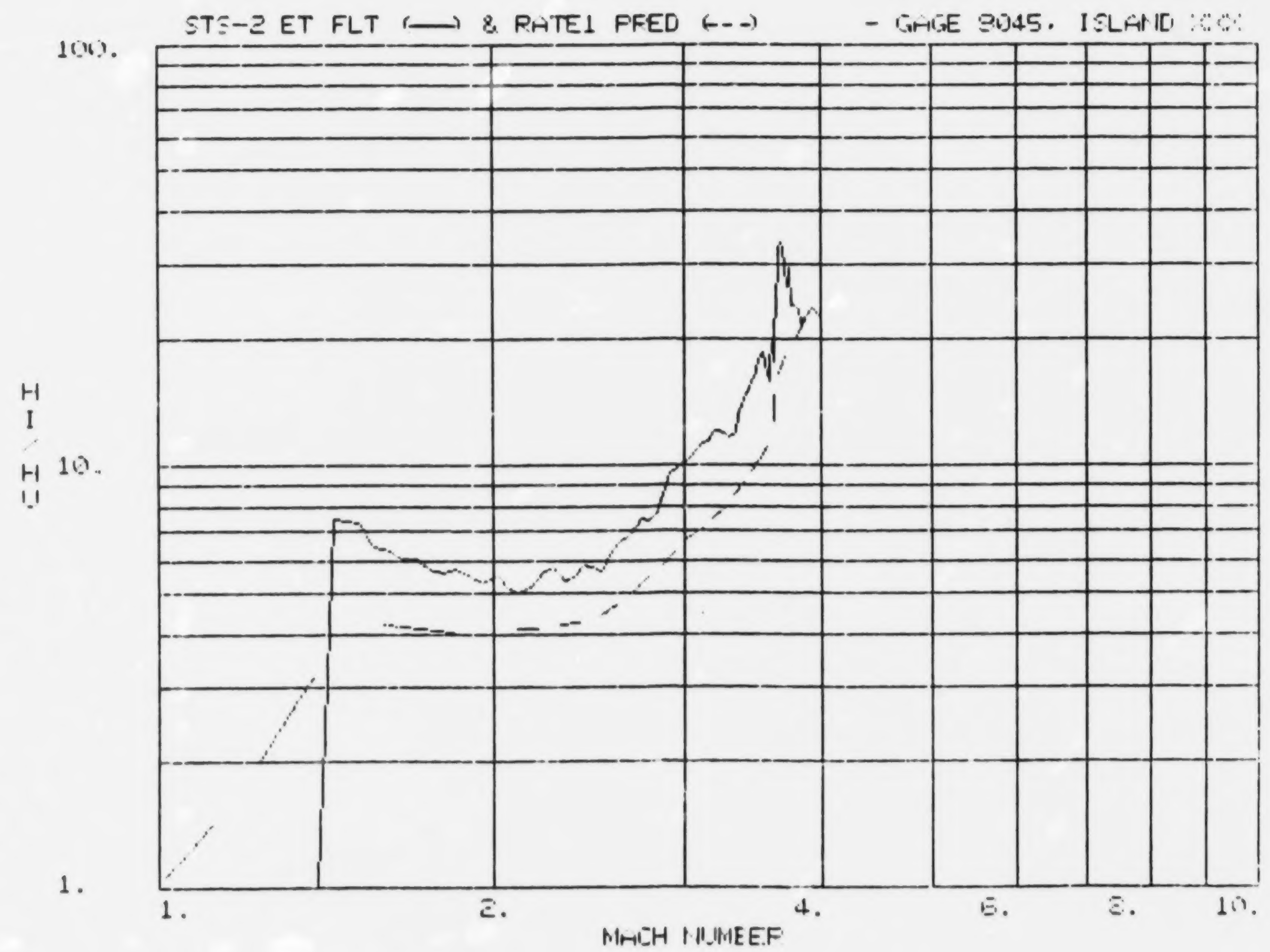
STS-2 ET FLT (——) & RATE1 PRED (- -) - GAGE 8045, ISLAND
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Fig. 2.30

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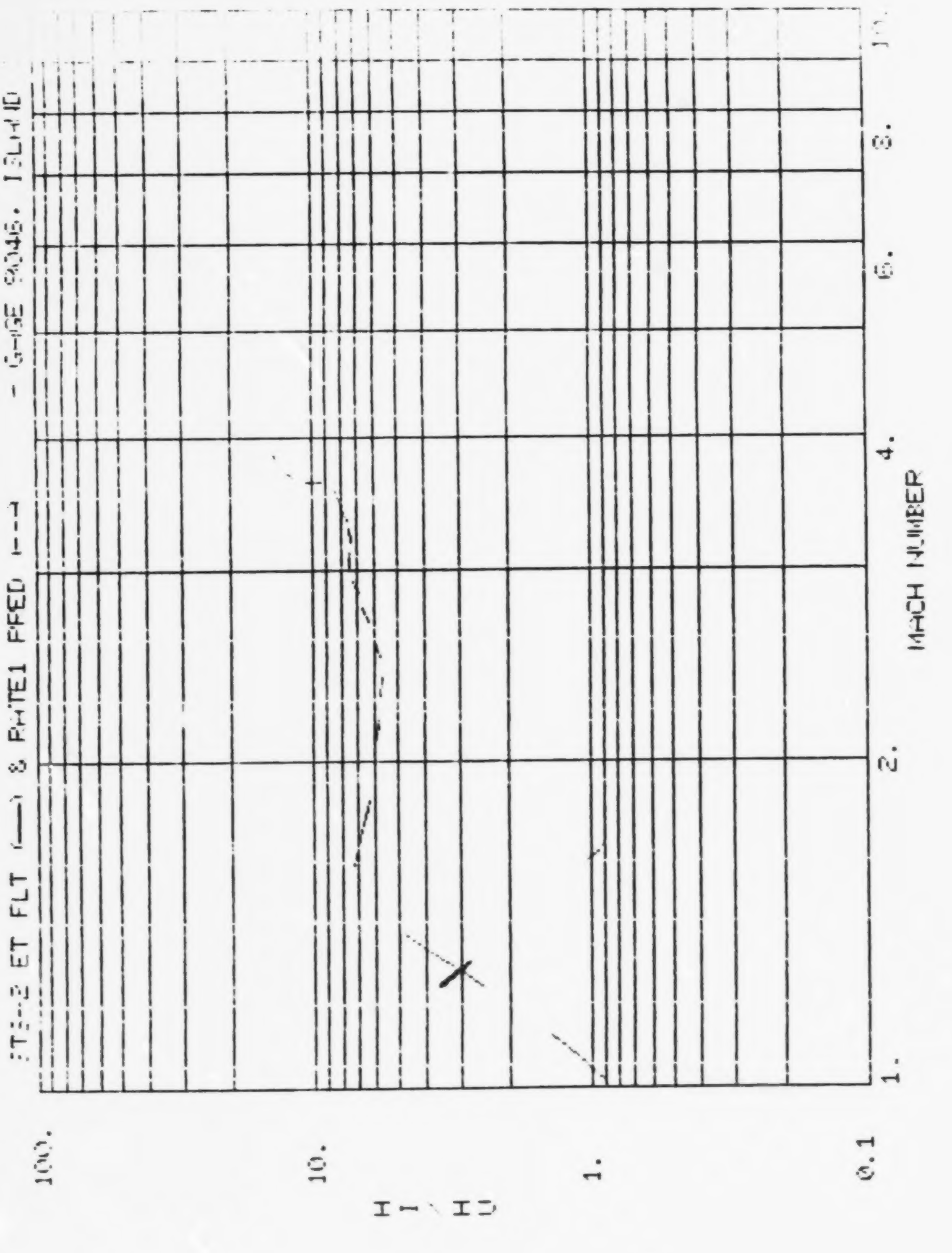

Fig. 2.31

NOTE: Bad Flight Data

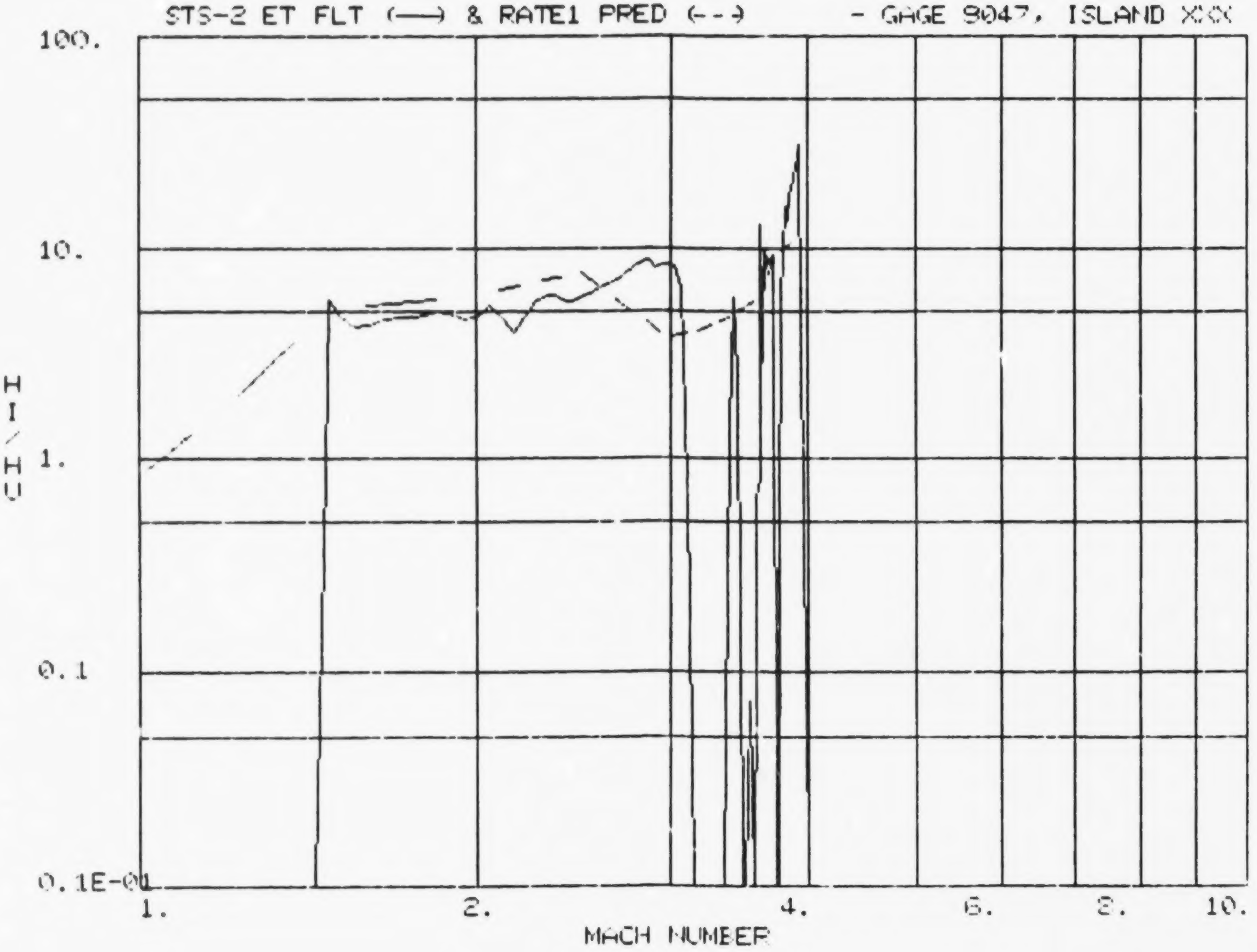
STS-2 ET FLT (——) & RATE1 PRED (- -) - GAGE 9047, ISLAND XXX
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Fig. 2.32

REMTECH INC.

SET 3

STS-3 pp. 3.1 - 3.34

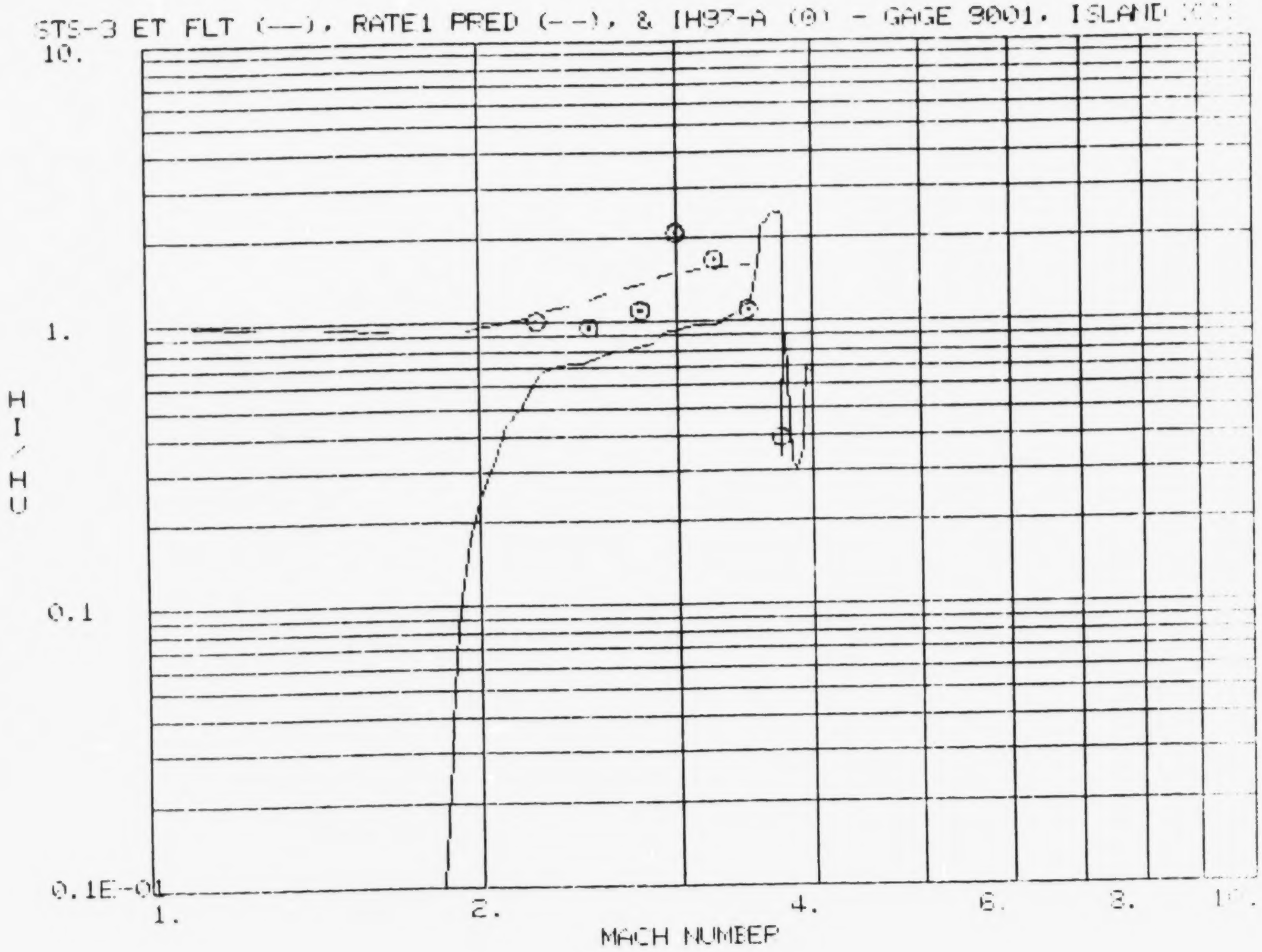
Table 3.1 STS-3 DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9001A	350.0	180.0	Ind. Gage	40° Cone
T07R9004A	467.4	264.0	Island 2	LO2 Tank
T07R9005A	467.4	174.0	Island 1	LO2 Tank
T07R9007A	672.5	270.0	Island 6	LO2 Tank
T07R9008A	672.5	180.0	Island 5	LO2 Tank
T07R9010A	825.5	270.0	Island 8	LO2 Tank
T07R9011A	976.0	25.0	Island 18	Intertank
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdin. Fairing (side)
T07R9013A	1110.4	2.5	Island 17(3)	Intertank
T07R9014A	937.4	288.6	Island 16	Intertank
T07R9015A	956.2	270.0	Island 15	Intertank
T07R9016A	937.4	251.4	Island 14	Intertank
T07R9017A	948.5	180.0	Island 12	Intertank
T07R9018A	1098.5	2.5	Island 17(2)	Intertank
T07R9019A	1084.4	2.5	Island 17(1)	Intertank
T07R9020A	1147.4	358.0	Island 27	LH2 Barrel
T07R9021A	1030.1	270.0	Island 20	Intertank
T07R9022A	1073.8	180.0	Island 23	Intertank
T07R9025A	1489.0	264.4	Island 29	LH2 Barrel
T07R9026A	1489.0	172.5	Island 28	LH2 Barrel
T07R9027A	2017.0	5.6	Island 33	LH2 Barrel
T07R9028A	2057.0	5.6	Island 35	LH2 Barrel
T07R9029A	2002.5	168.7	Island 32	LH2 Barrel
T07R9030A	2038.97	356.3	Island 34	LH2 Barrel
T07R9031A	2057.0	276.0	Island 36	LH2 Barrel
T07R9032A	2057.0	340.6	Island 37	LH2 Barrel
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdin Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2100.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2035.0	26.0	Ind. Gage	Fwd. LO2 Fdin/X-Beam Cable Tray

REMTECH INC.

Table 3.2 STS-3 ET INTERFERENCE FACTORS FROM THE IH-97A WIND TUNNEL DATA BASE

GAGE NO.	IH97A NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9001	5029	1.020	0.966	1.10[illegible]	2.072	1.660	1.110	0.390
9004	5031	1.011	0.994	0.975	0.970	0.967	0.956	0.917
9005	5030	0.958	0.951	1.005	0.914	0.928	0.924	0.845
9007	5033	0.930	0.948	1.029	0.997	0.967	0.874	0.849
9008	5032	1.132	1.145	1.122	1.169	1.129	1.130	1.043
9010	5034	0.459	0.445	0.440	0.420	0.341	0.329	0.356
9011	5042	1.129	1.063	0.857	0.707	1.076	1.650	1.429
9013	5041	—	—	—	4.092	3.119	3.207	3.438
9014	5038	3.655	3.498	4.058	—	5.193	5.962	6.272
9015	5258	4.675	6.596	—	7.332	8.050	11.900	9.458
9016	5036	4.576	4.055	3.999	4.398	4.802	5.773	5.482
9017	5035	0.666	0.641	0.650	0.747	0.753	0.787	0.810
9018	5039	3.345	3.924	3.862	—	3.071	2.806	3.119
9019	5040	2.955	3.338	3.003	2.742	2.366	1.956	2.199
9020	5250	2.864	3.400	4.367	5.020	5.972	6.213	5.010
9021	5043	0.157	0.325	0.476	0.661	1.006	1.156	1.157
9022	5044	1.238	1.224	0.876	0.695	0.704	0.744	0.774
9023	5249	3.338	3.872	3.880	4.152	4.725	4.436	3.109
9024	5251	1.027	1.124	1.729	1.540	1.768	1.973	1.868
9025	5046	1.127	1.104	0.855	0.819	0.939	0.682	0.620
9026	5045	0.700	0.775	0.832	0.808	0.792	0.793	0.834
9027	5048	1.113	1.227	1.767	1.893	1.979	1.710	2.565
9028	5050	1.131	1.340	1.591	1.861	2.202	2.416	2.213
9029	5047	0.464	0.439	0.396	0.388	0.417	0.039	0.140
9030	5049	3.210	2.124	2.618	3.247	3.320	6.665	3.028
9031	5051	3.305	3.153	4.875	2.822	6.186	7.201	7.136
9032	5052	2.480	2.939	2.619	3.687	3.980	3.190	4.431
9033	5252	1.556	1.254	1.745	1.398	0.953	1.422	0.726



STS-3 ET FLT (—), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9001, ISLAND
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Fig. 3.1

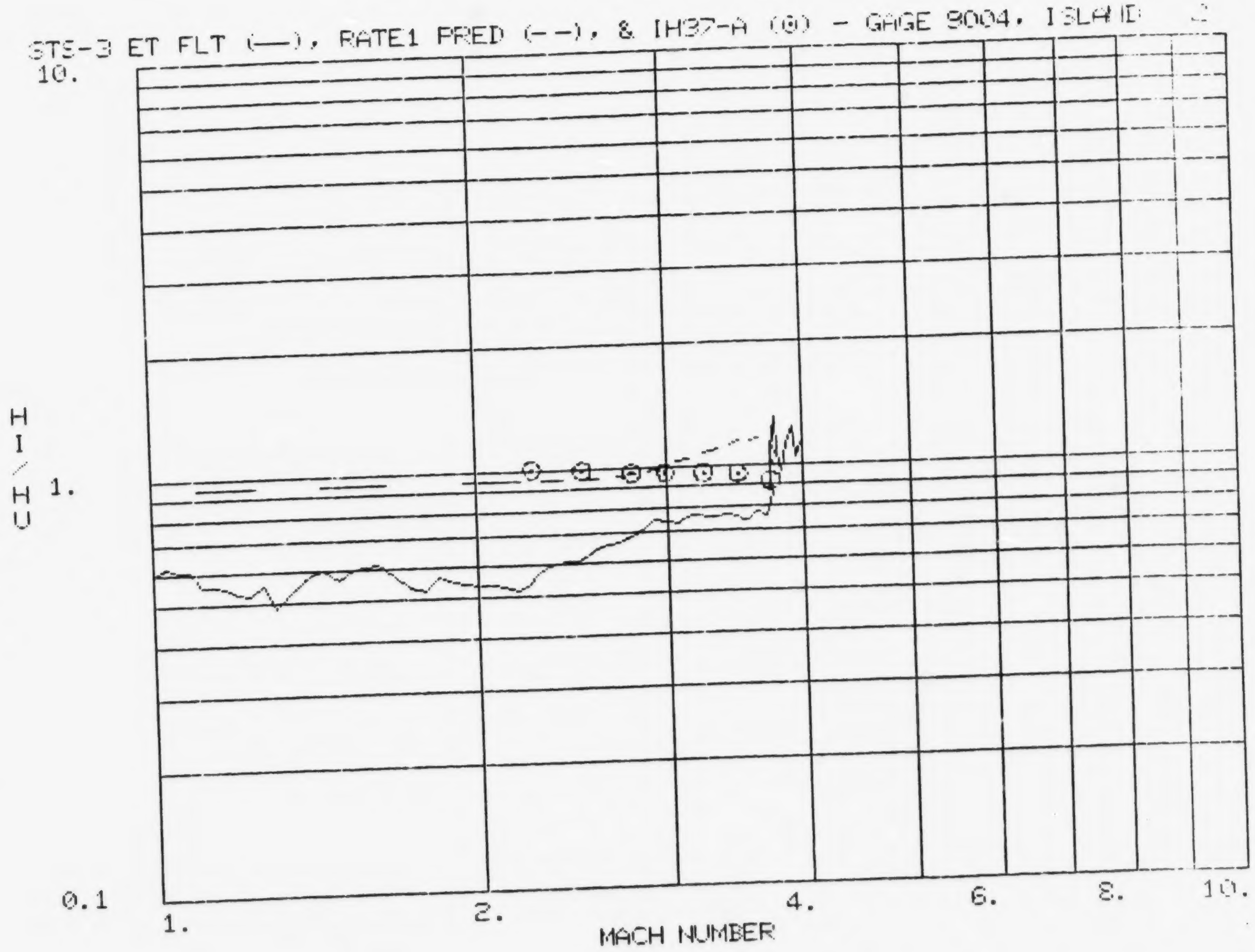
STS-3 ET FLT (—), RATE1 PRED (- -), & IH37-A (⊙) - GAGE 9004, ISLAND 2
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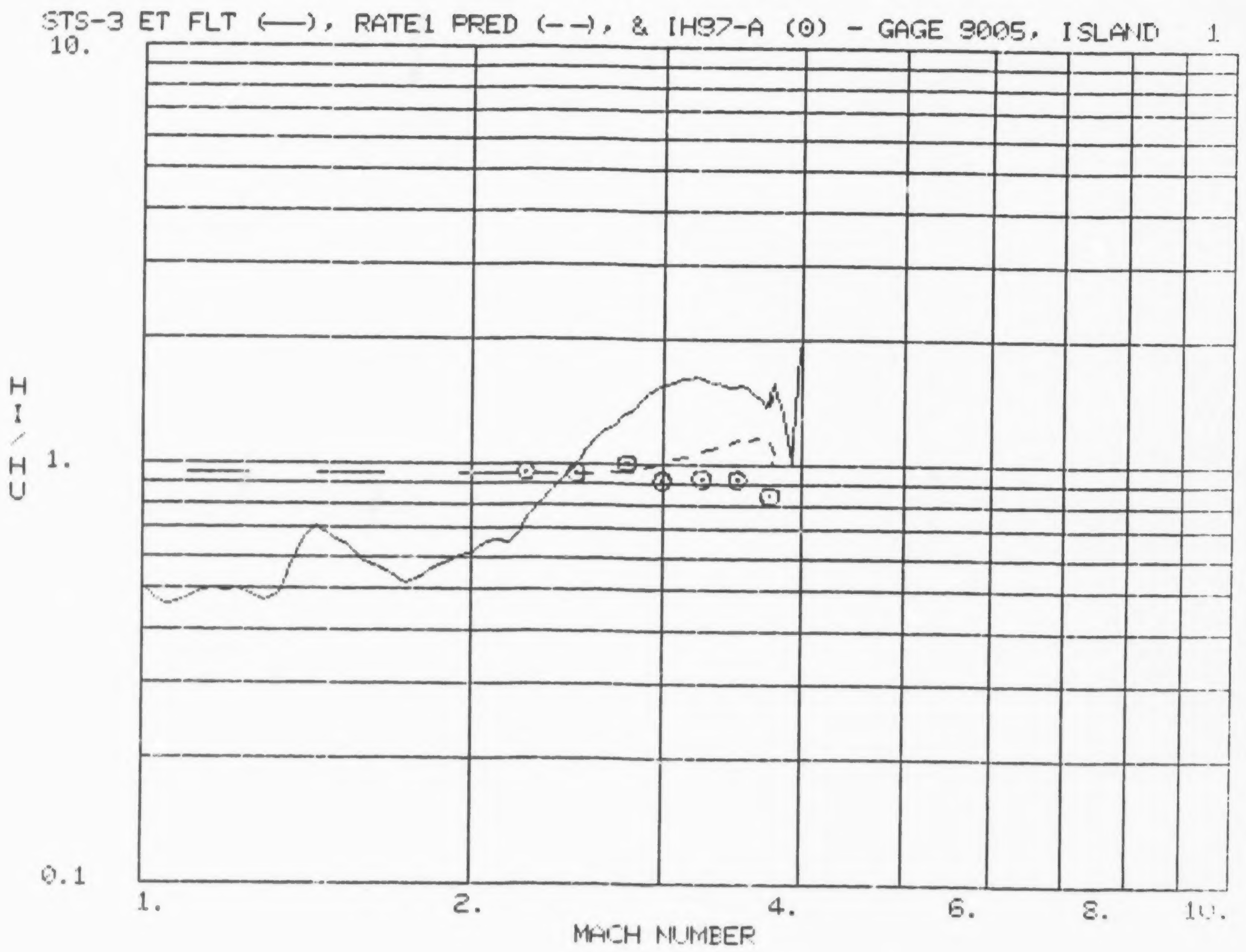
Fig. 3.2



STS-3 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9005, ISLAND 1
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Fig. 3.3

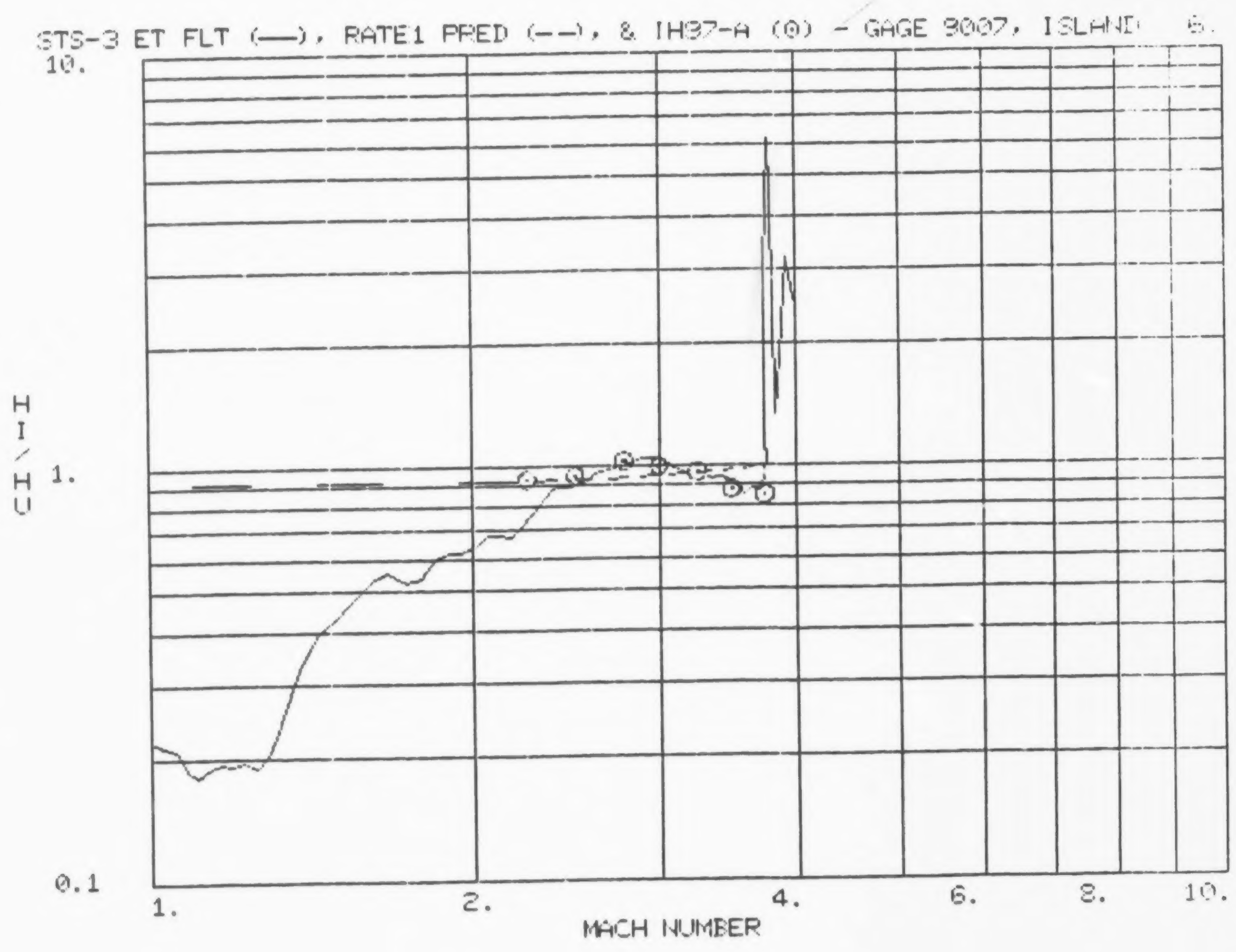
STS-3 ET FLT (—), RATE1 PRED (--), & IH37-A (⊙) - GAGE 9007, ISLAND 5.
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Fig. 3.4

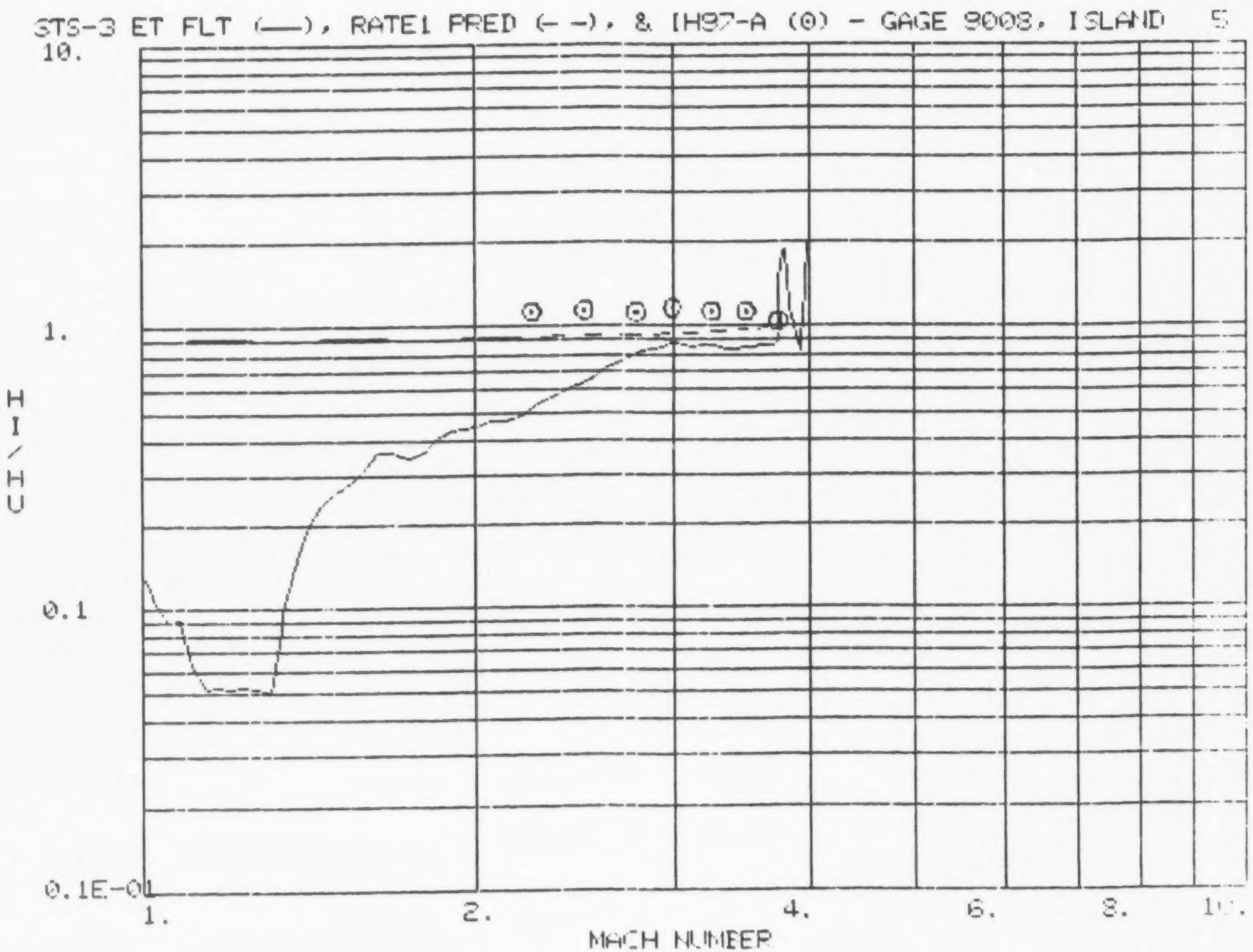
STS-3 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9008, ISLAND 5
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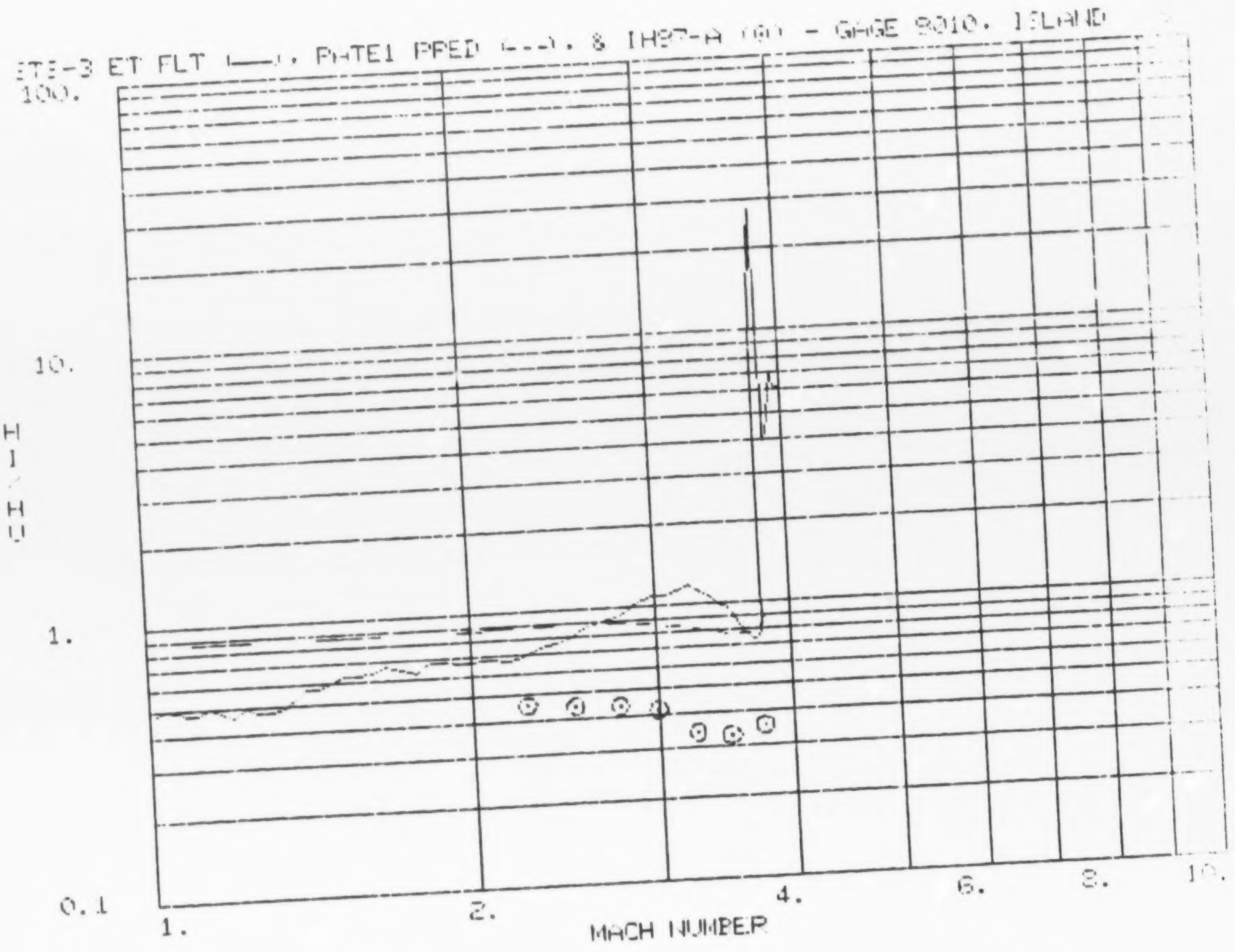
Fig. 3.5



PHTE1 PRED
IH97-A
GAGE 9010. ISLAND
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Fig. 3.6

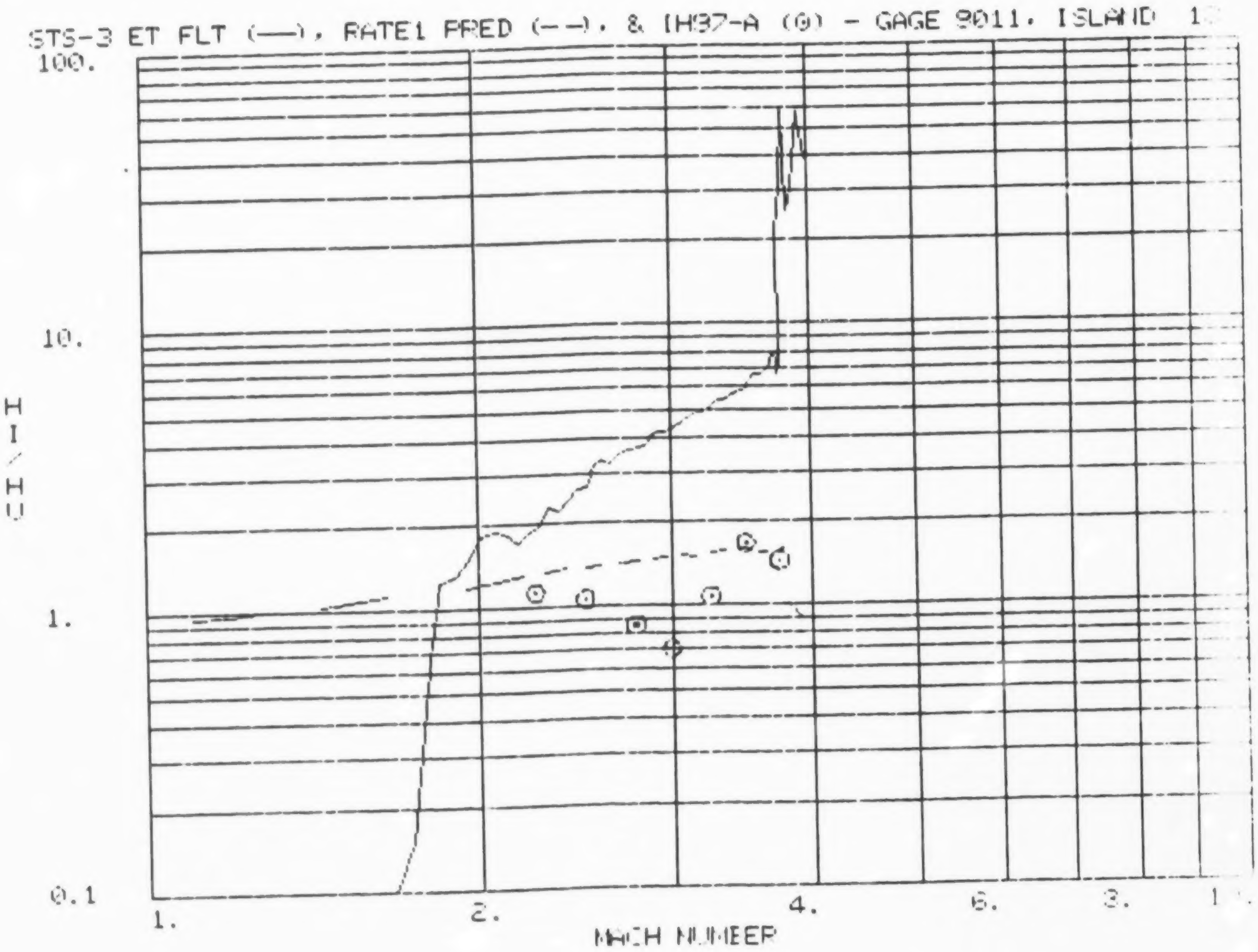
STS-3 ET FLT (—), RATE1 PRED (– –), & IH37-A (⊙) - GAGE 9011, ISLAND 1
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Fig. 3.7

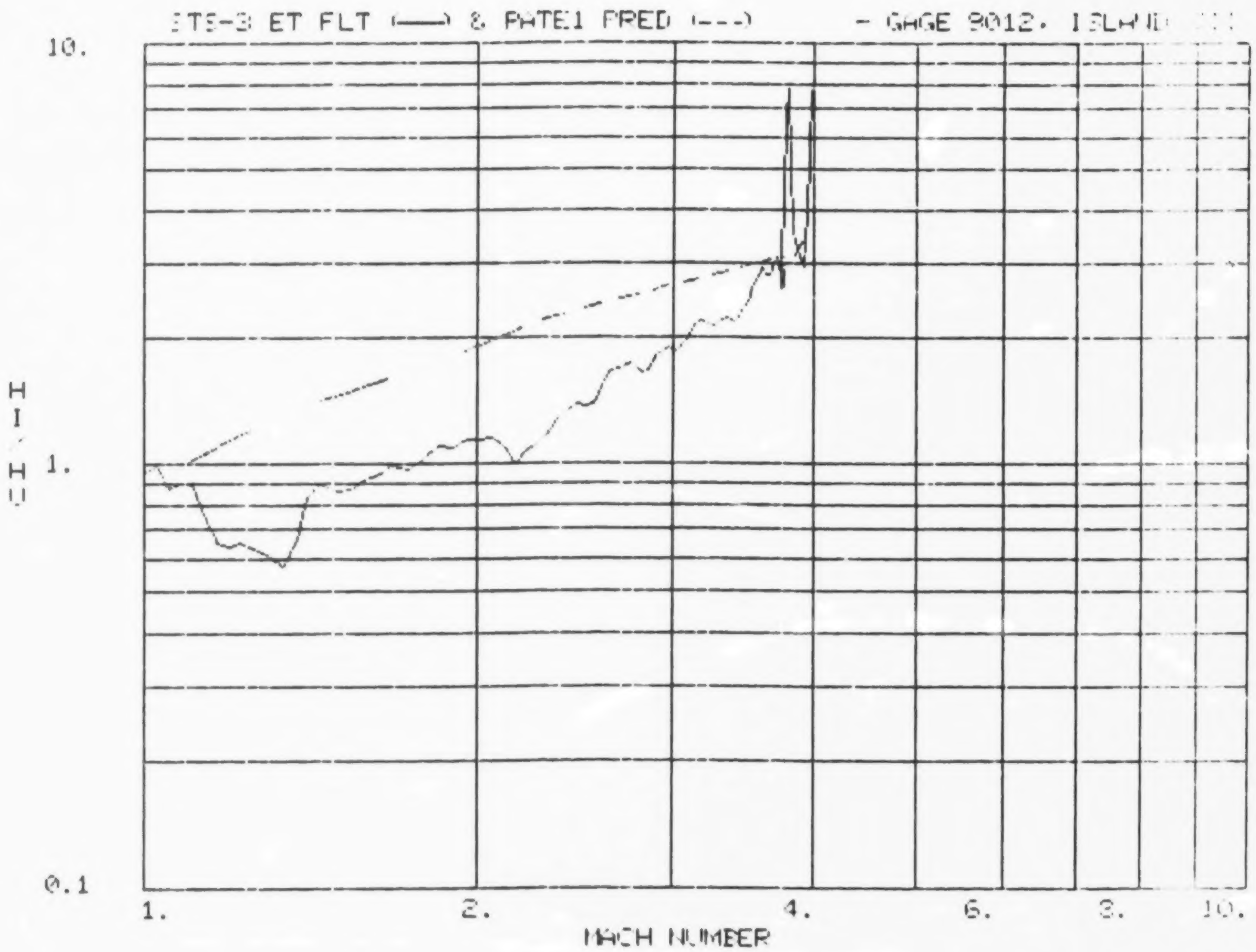
STS-3 ET FLT (——) & PATE1 PRED (---) - GAGE 9012. ISLAND
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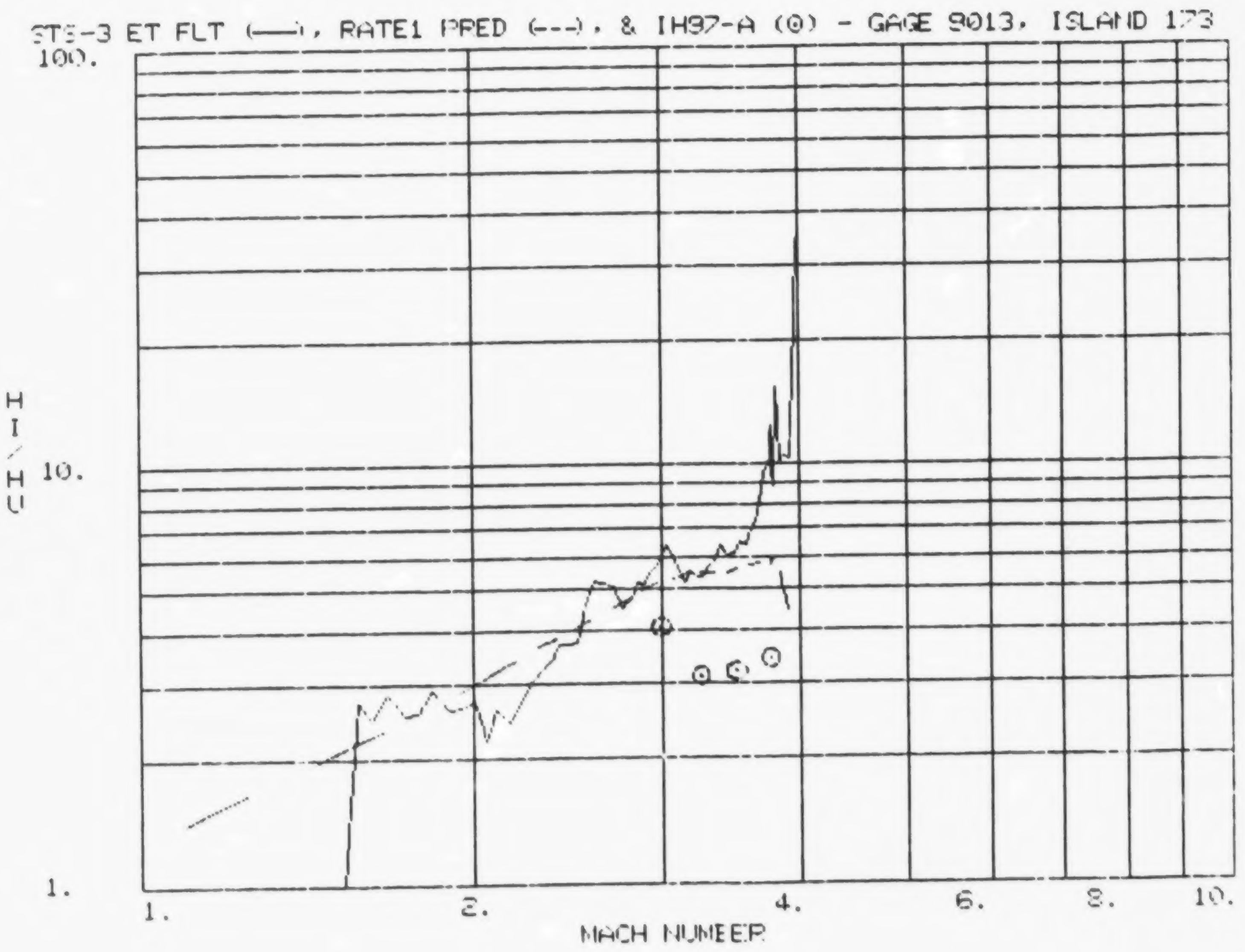
Fig. 3.8



STS-3 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9013, ISLAND 173
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Fig. 3.9

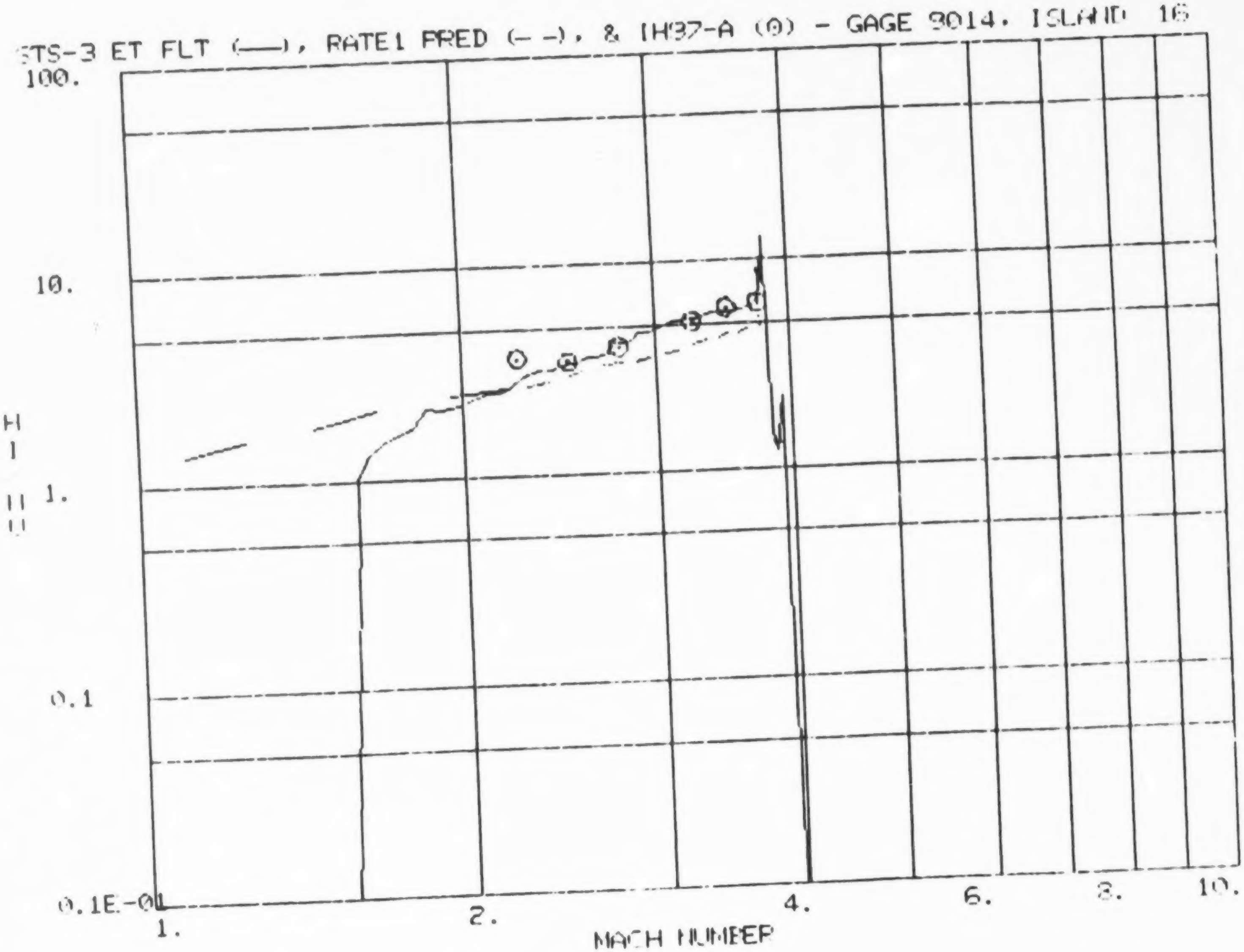

Fig. 3.10

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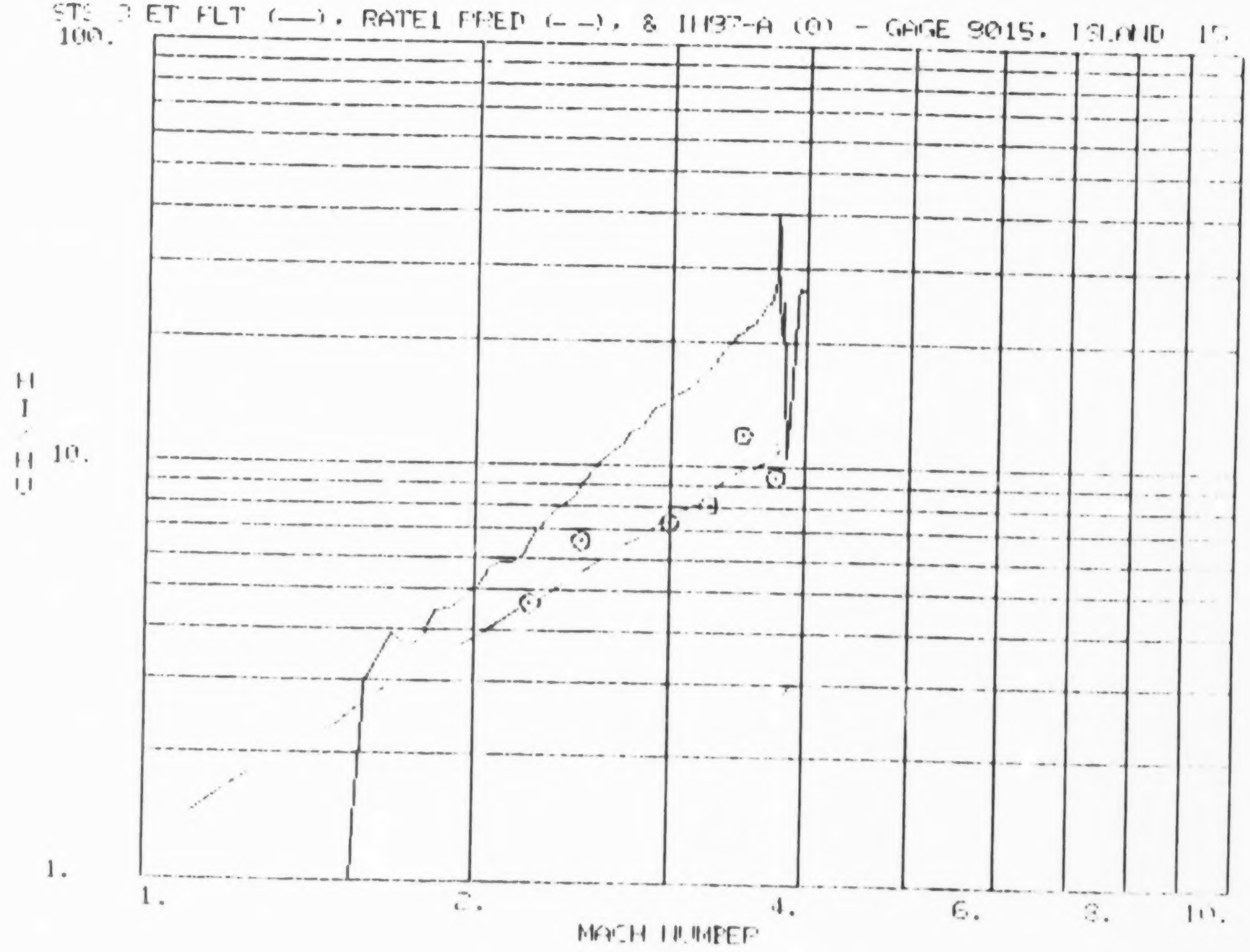
STS 3 ET FLT (—), RATEL PRED (- -), & IH37-A (0) - GAGE 9015, ISLAND 15
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Fig. 3.11

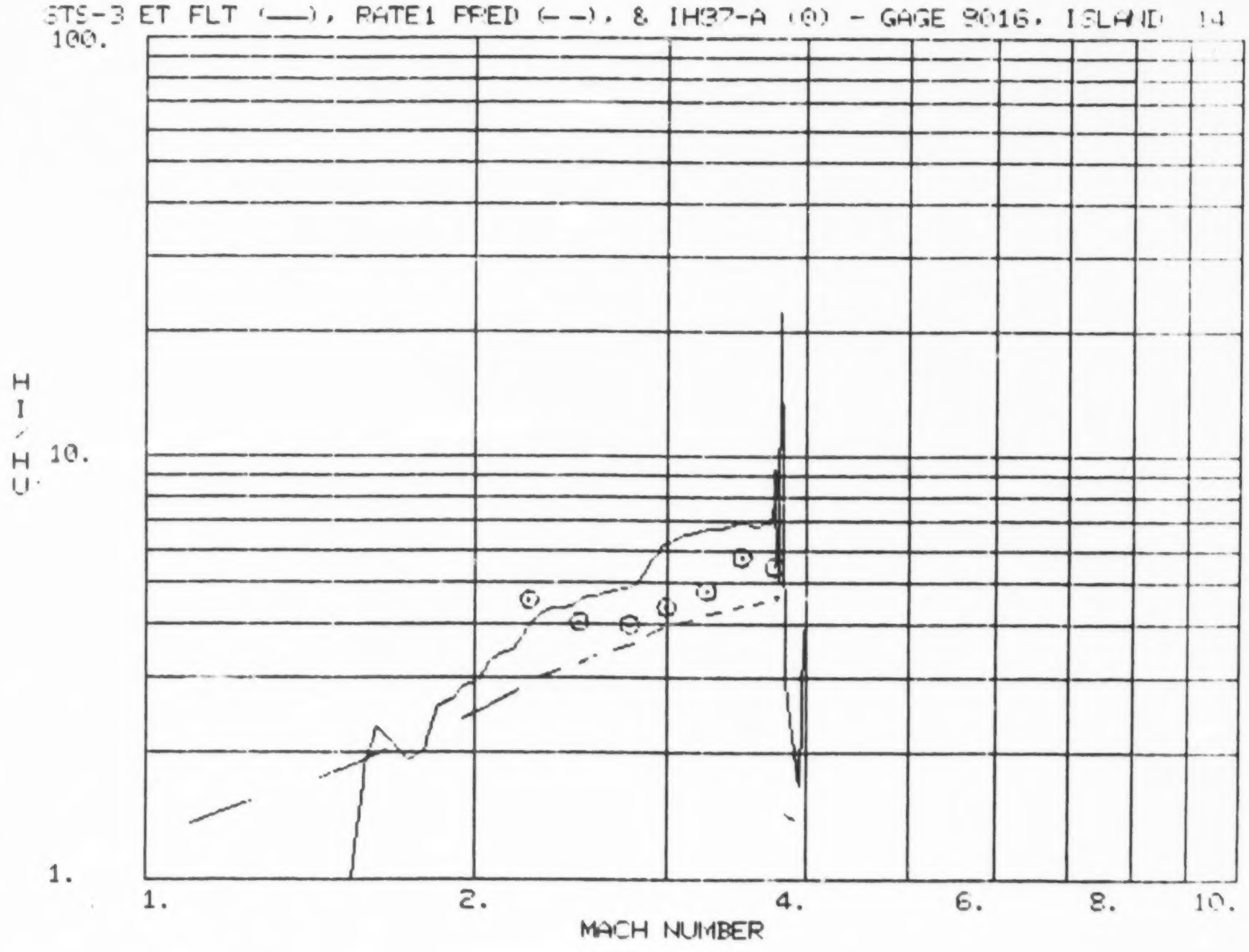
STS-3 ET FLT (—), RATE1 PRED (- -), & IH37-A (⊙) - GAGE 9016, ISLAND 14
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Fig. 3.12

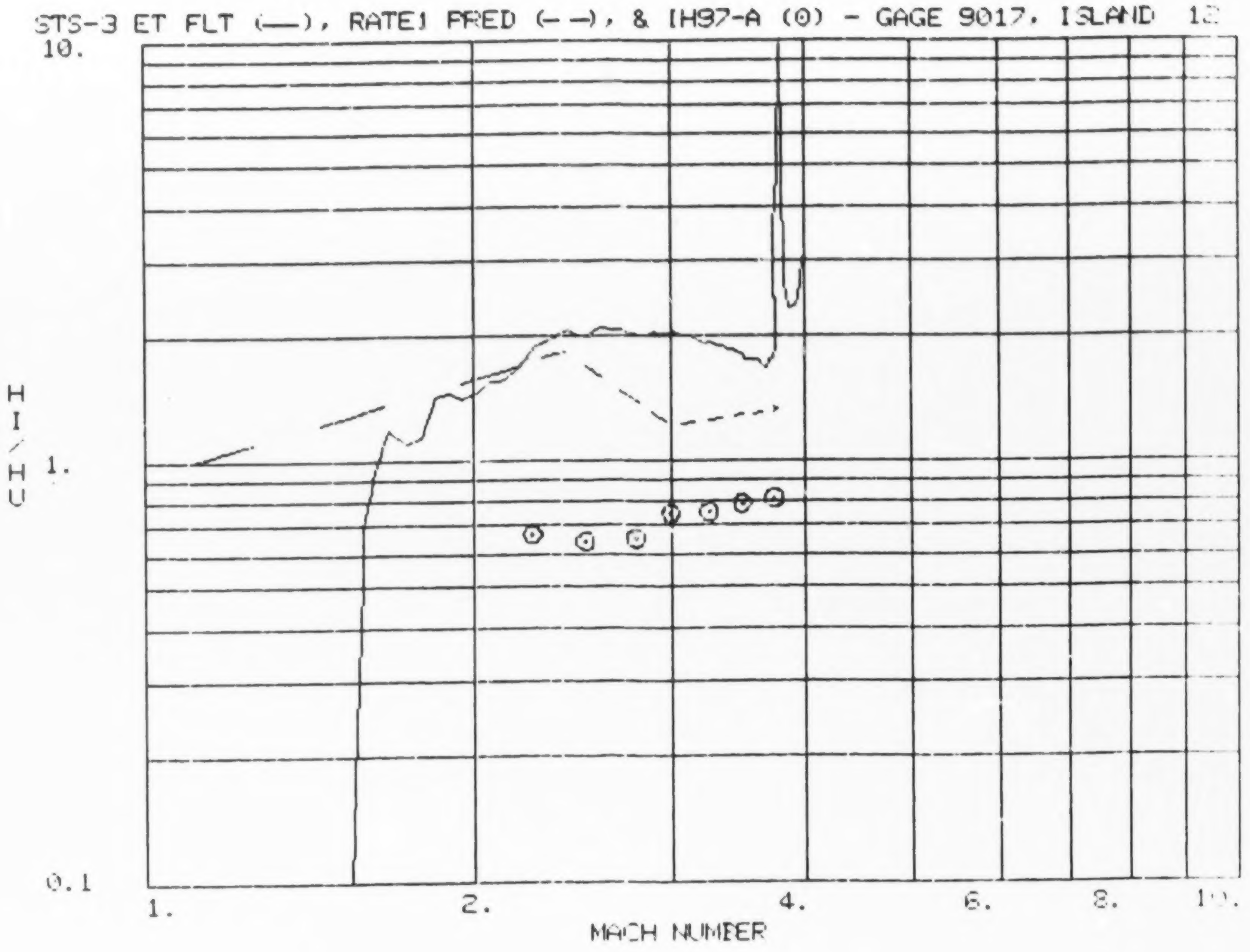
STS-3 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9017, ISLAND 12
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Fig. 3.13

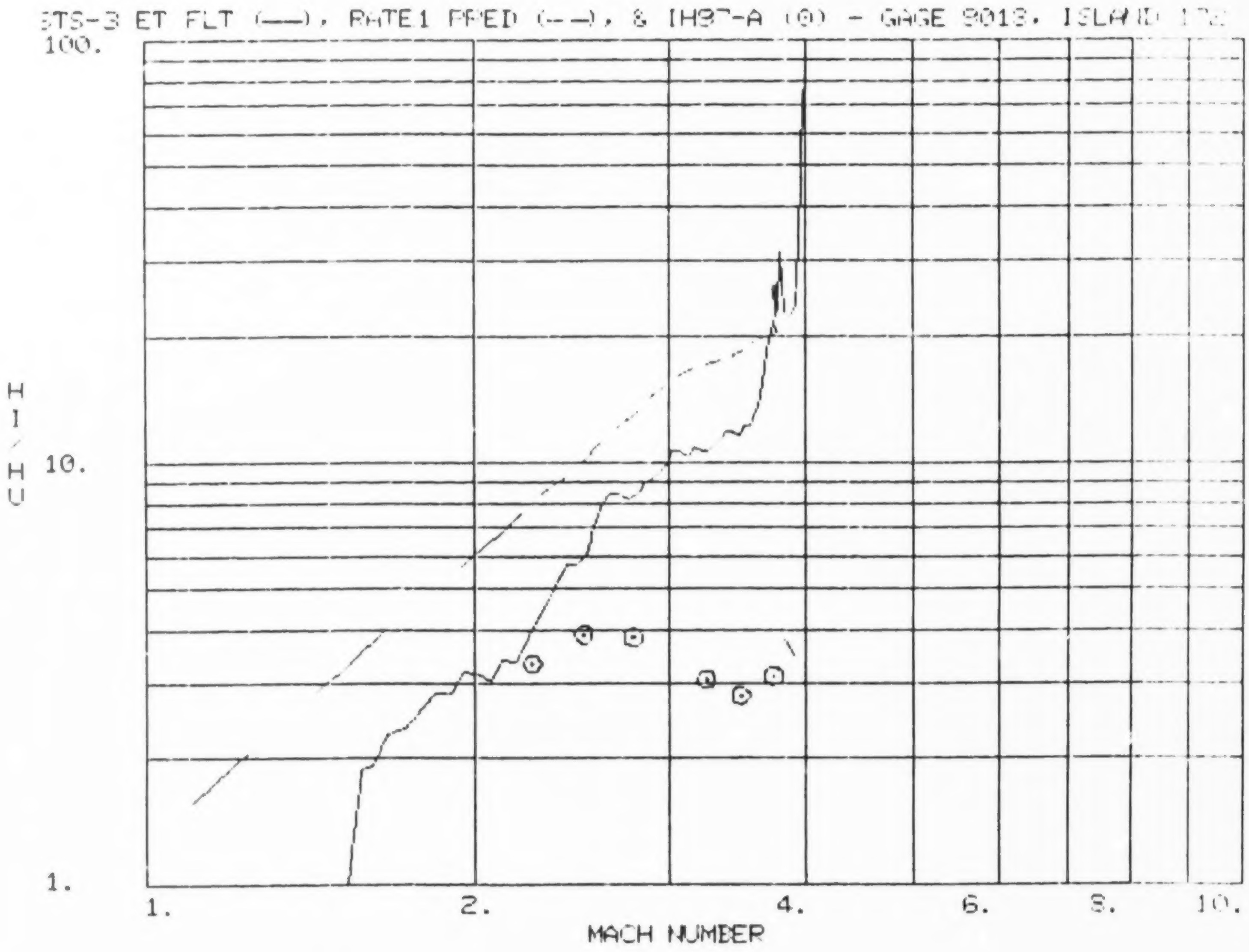
STS-3 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9013, ISLAND 172
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Fig. 3.14

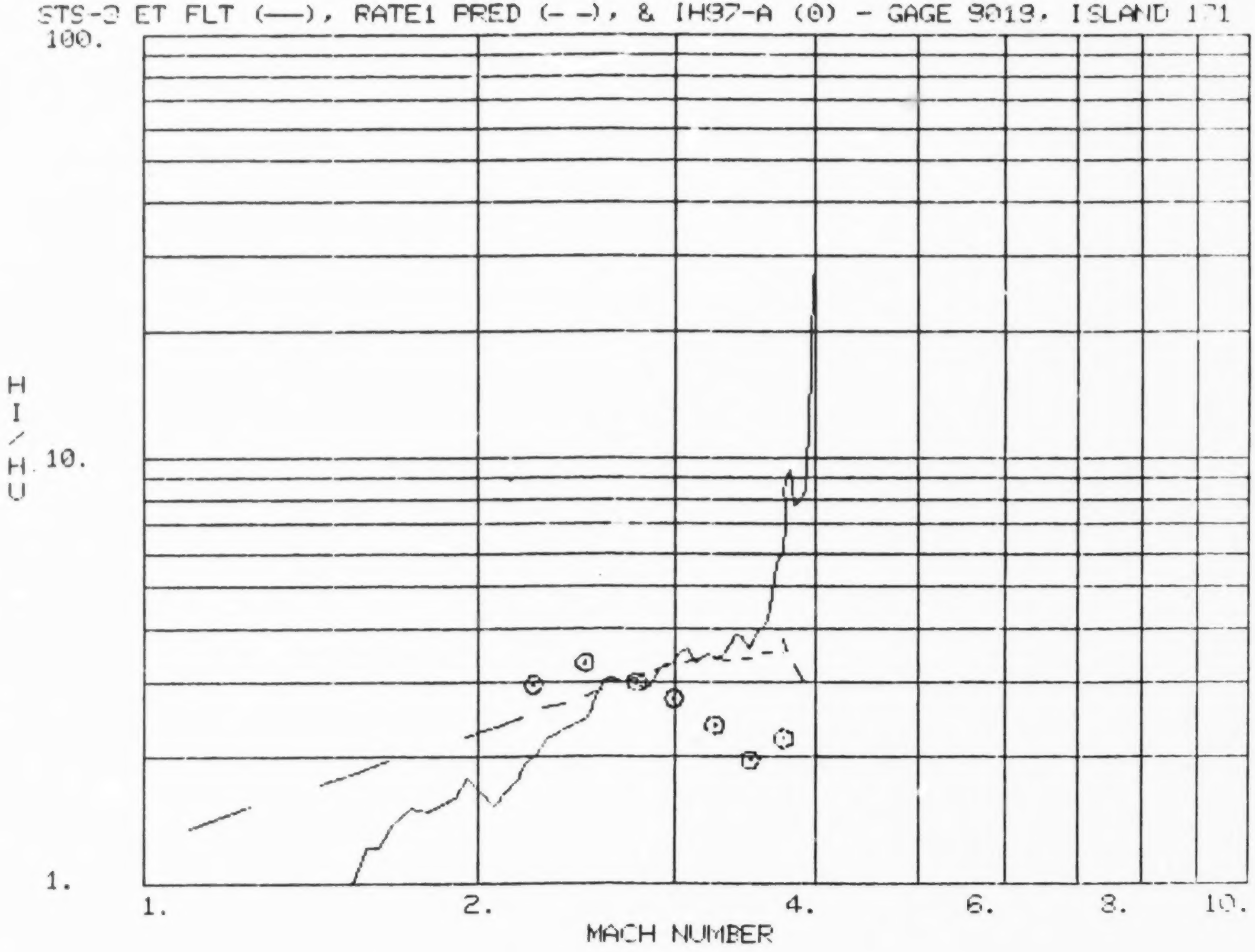
STS-3 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9019, ISLAND 1?1
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Fig. 3.15

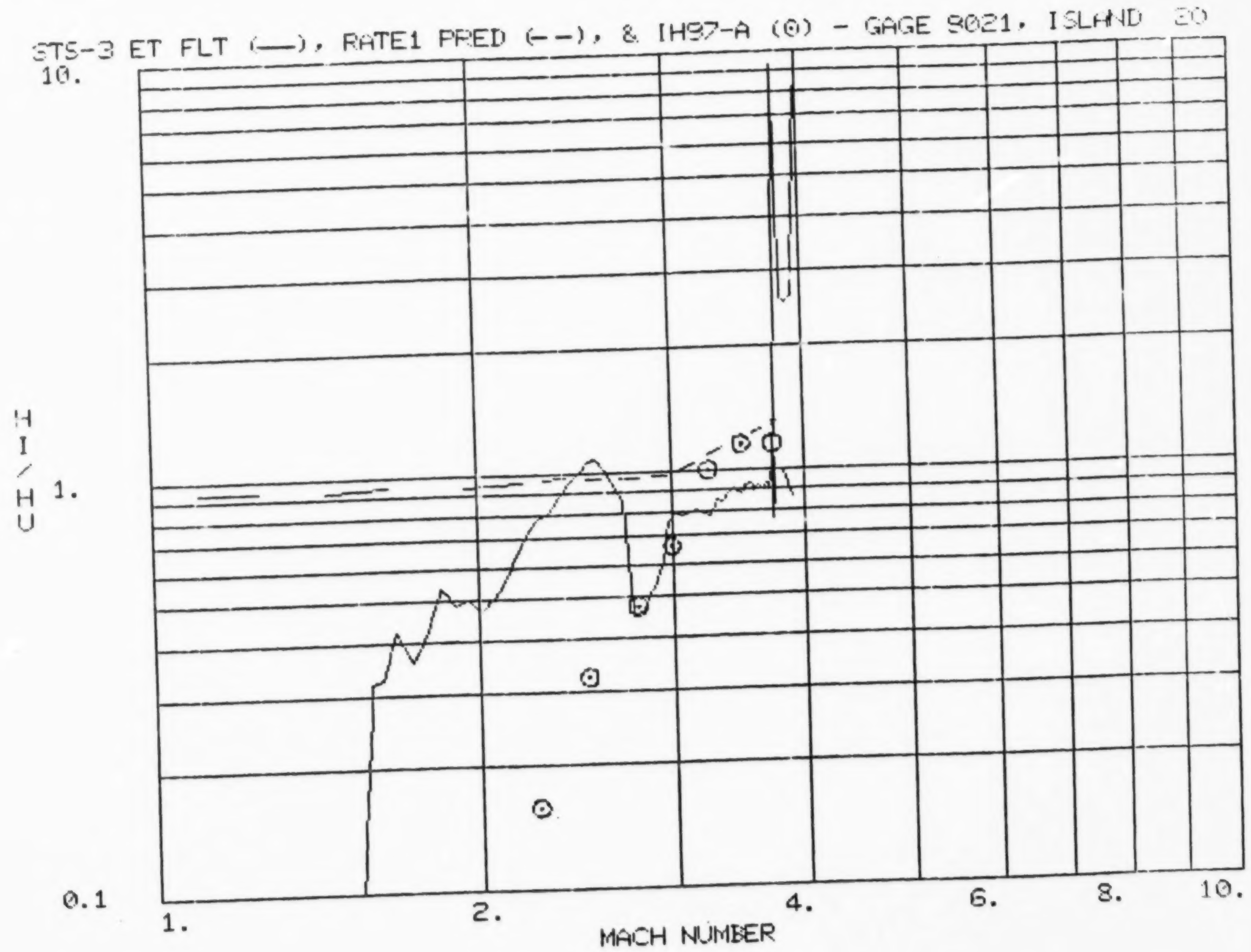
STS-3 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9021, ISLAND 20
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Fig. 3.16

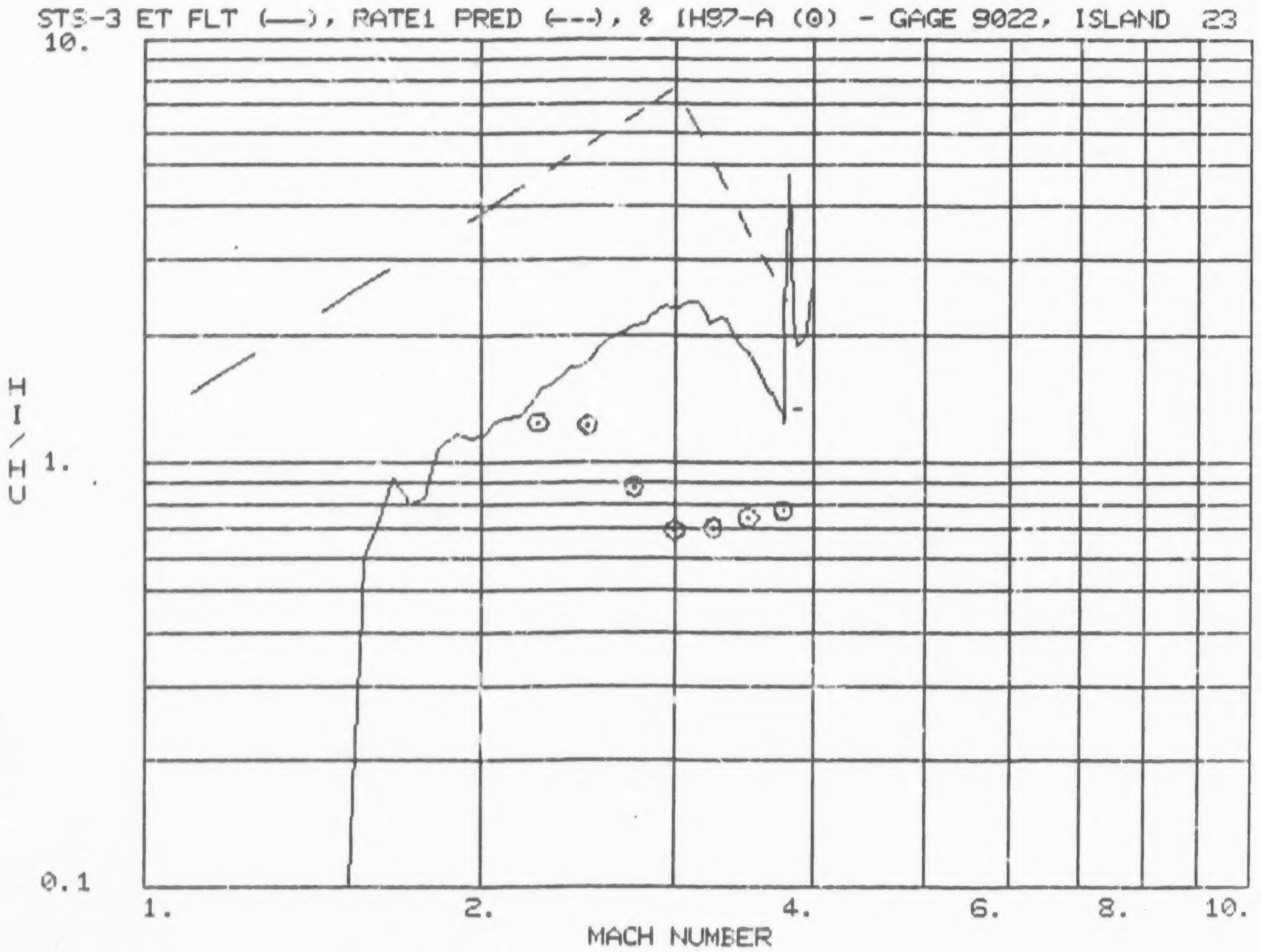

Fig. 3.17

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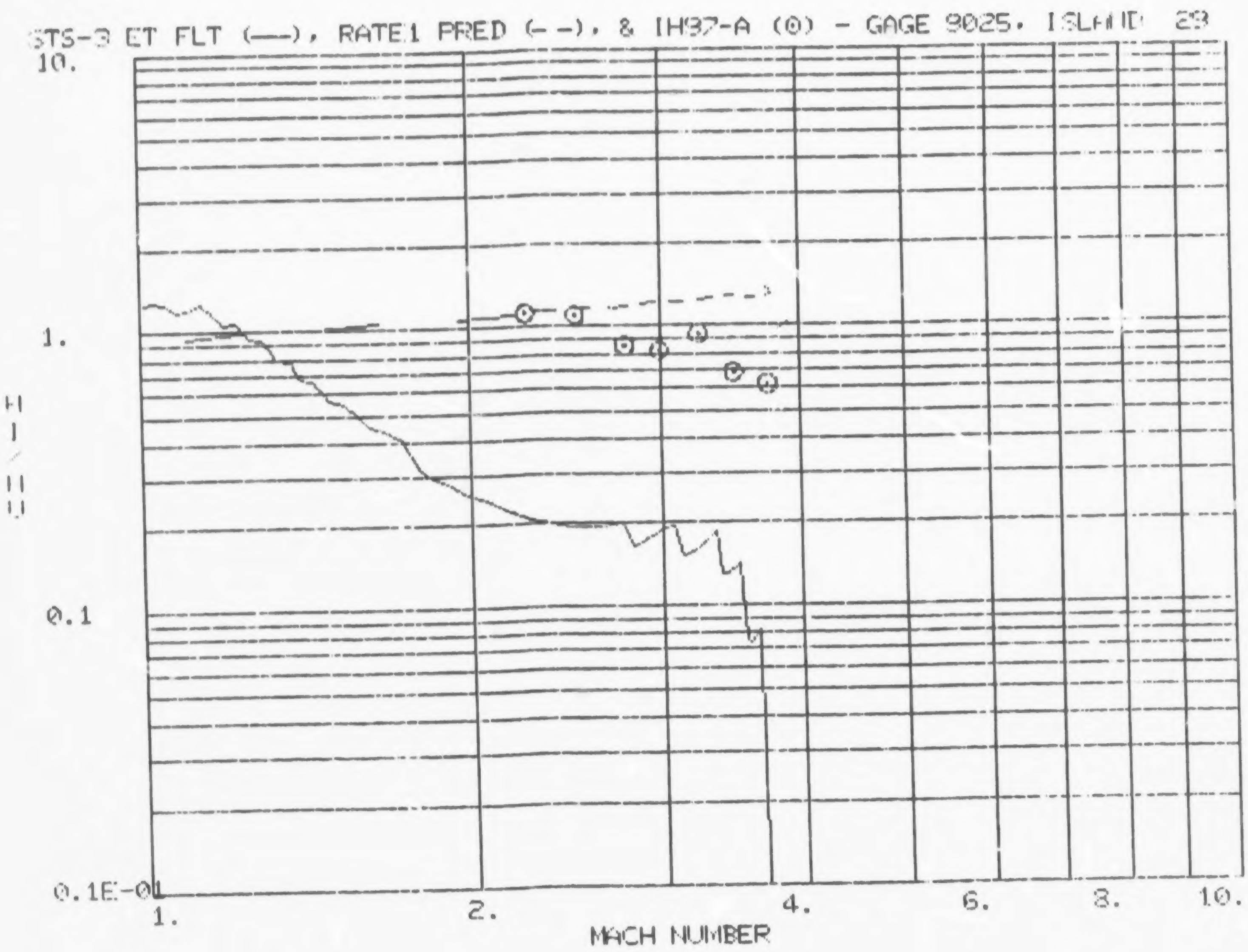
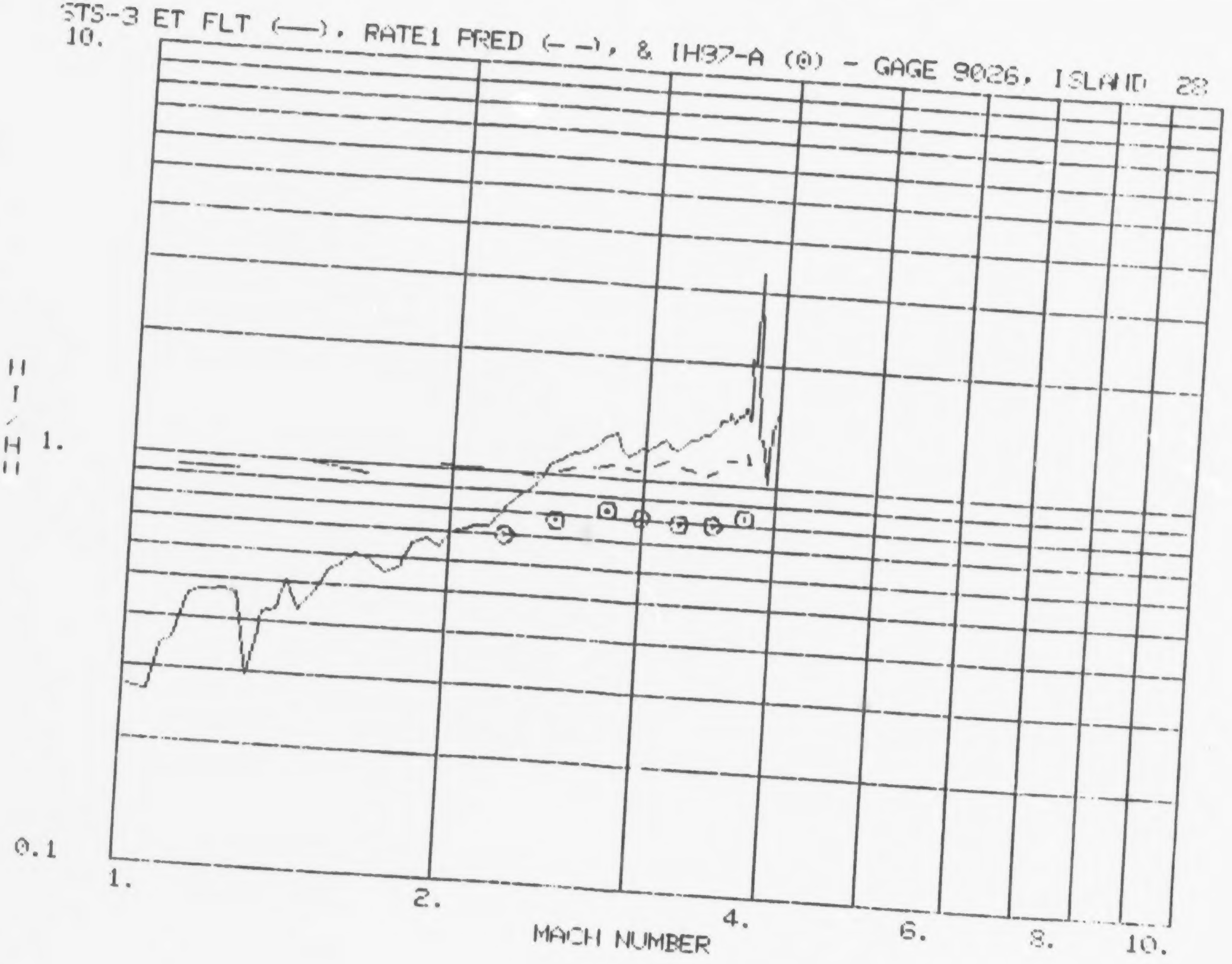


Fig. 3.18



STS-3 ET FLT (—), RATE1 PRED (– –), & IH37-A (⊙) - GAGE 9026, ISLAND 28
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MACH NUMBER

Fig. 3.19

STS-3 ET FLT (——), RATE1 PRED (– –), & IH37-A (⊙) - GAGE 9027, ISLAND 33

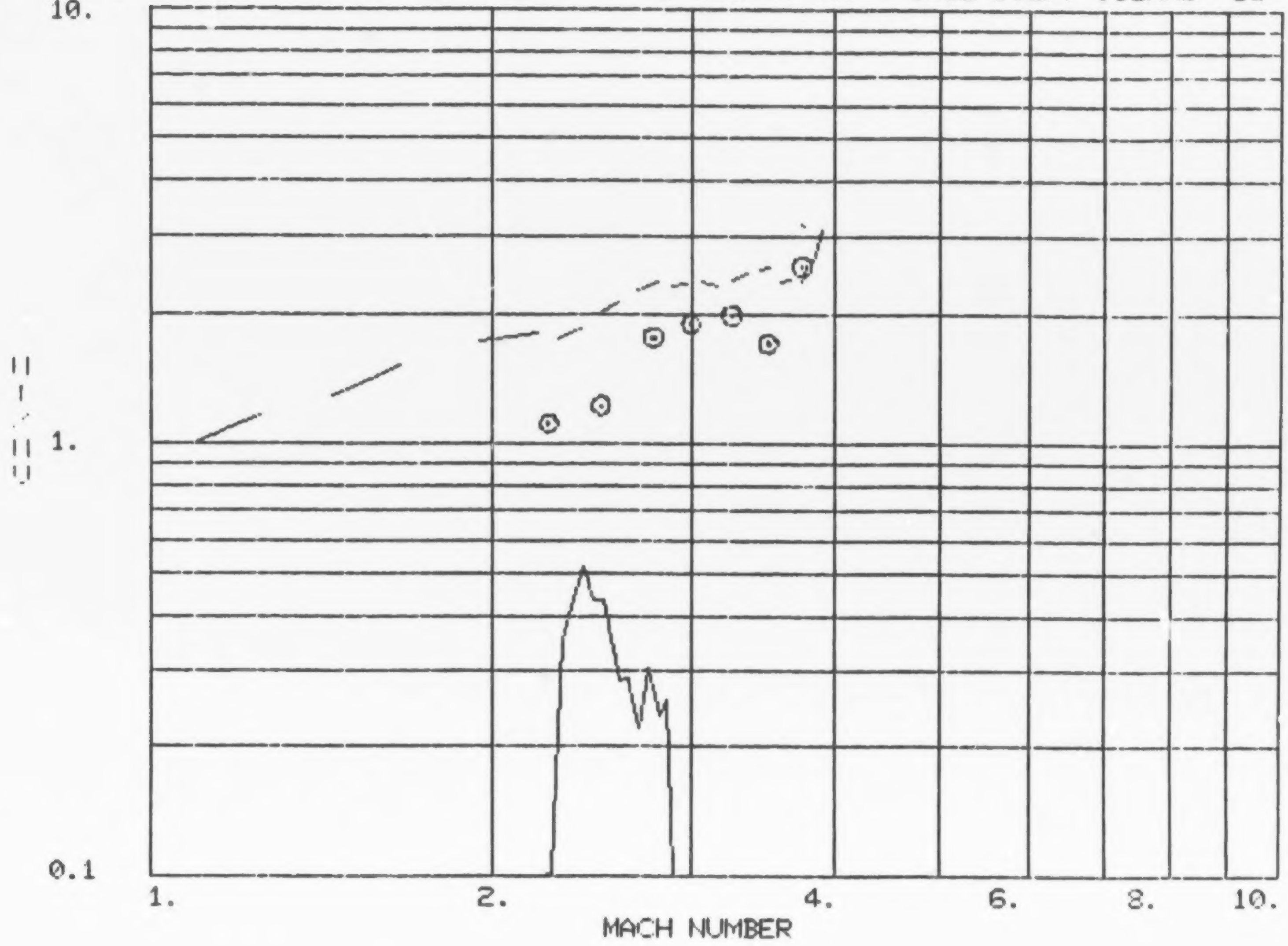

Fig. 3.20

NOTE: Bad Flight Data

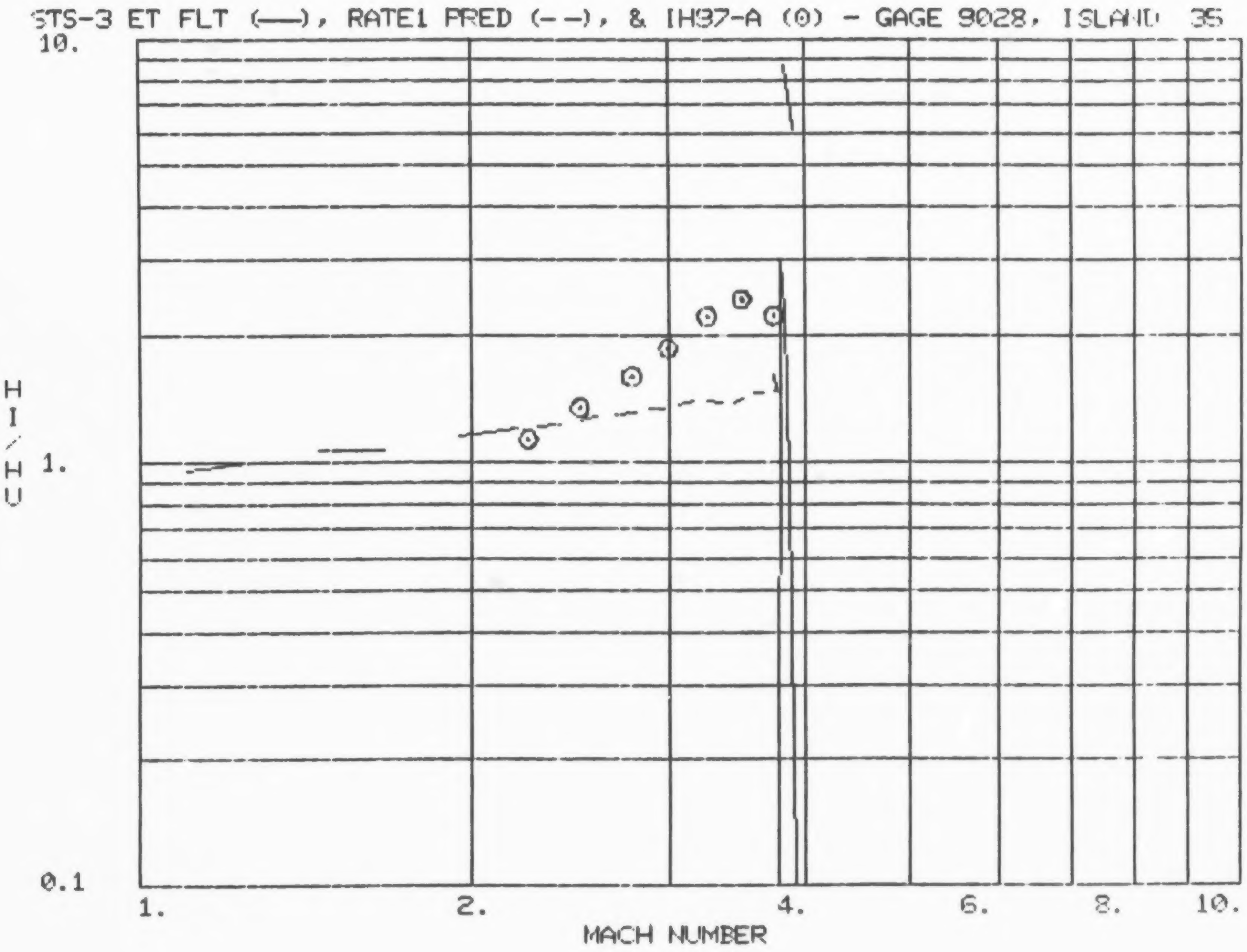

Fig. 3.21

NOTE: BAD FLIGHT DATA

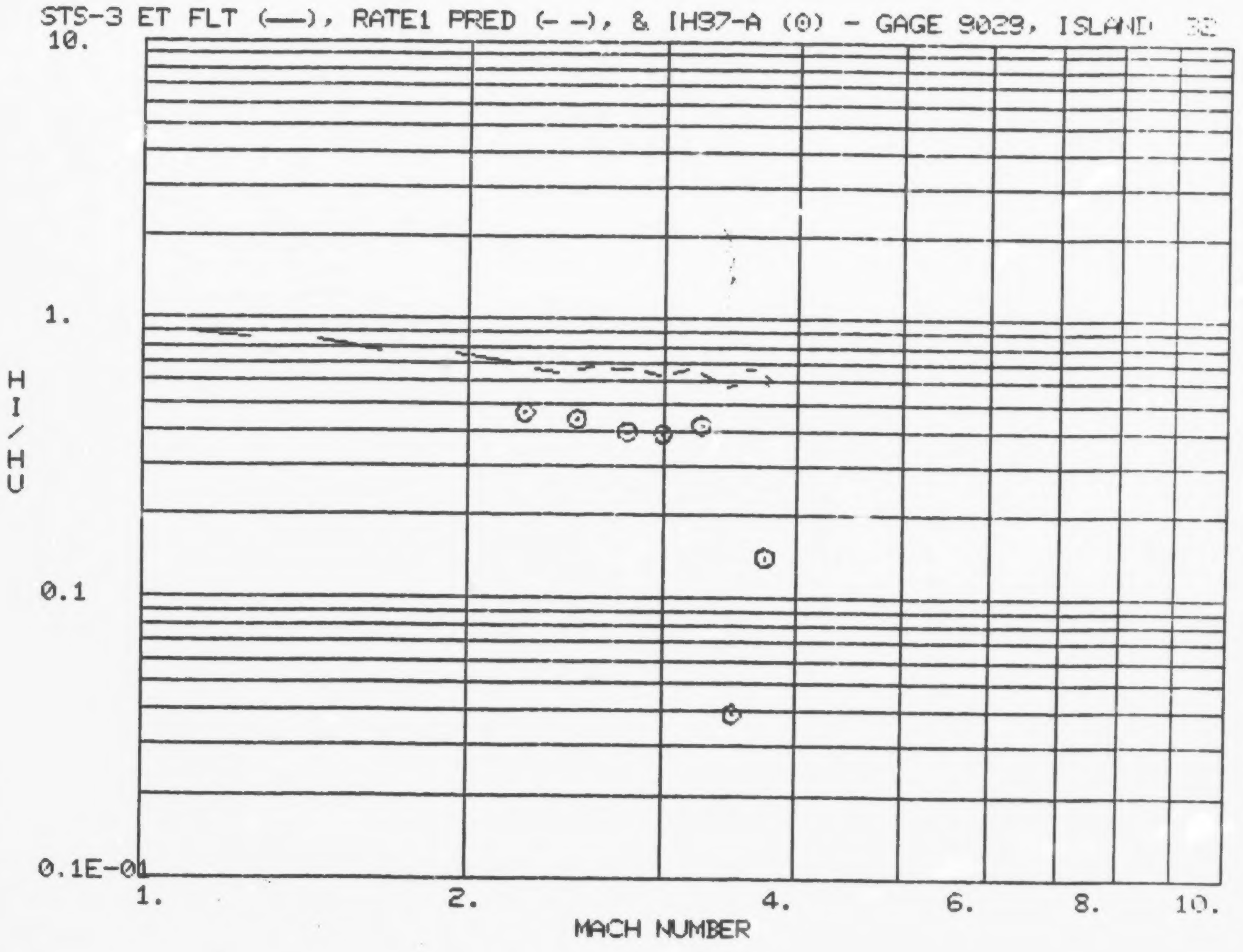
STS-3 ET FLT (——), RATE1 PRED (- -), & IH37-A (⊙) - GAGE 9029, ISLAND 32
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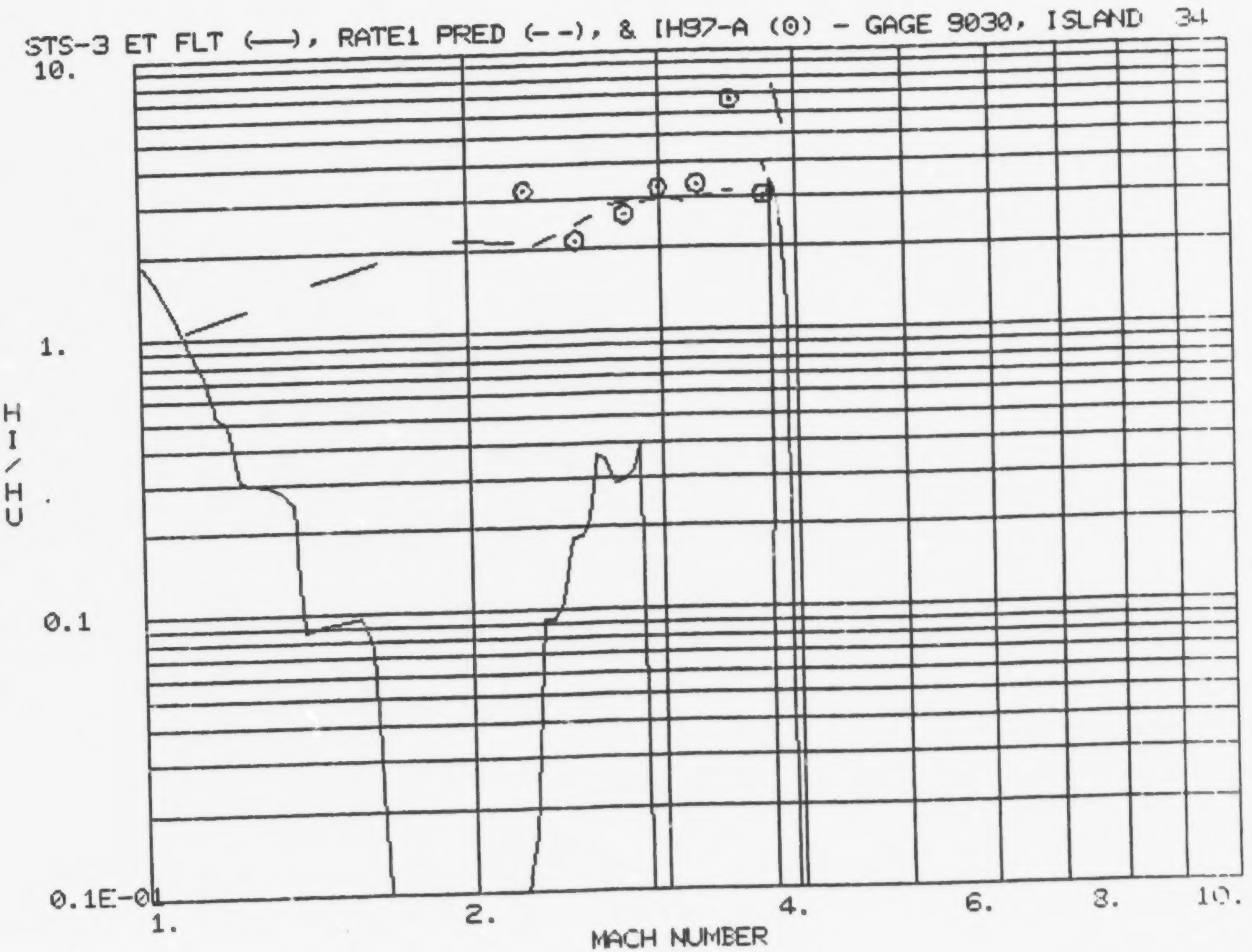
Fig. 3.22



STS-3 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9030, ISLAND 34
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Fig. 3.23

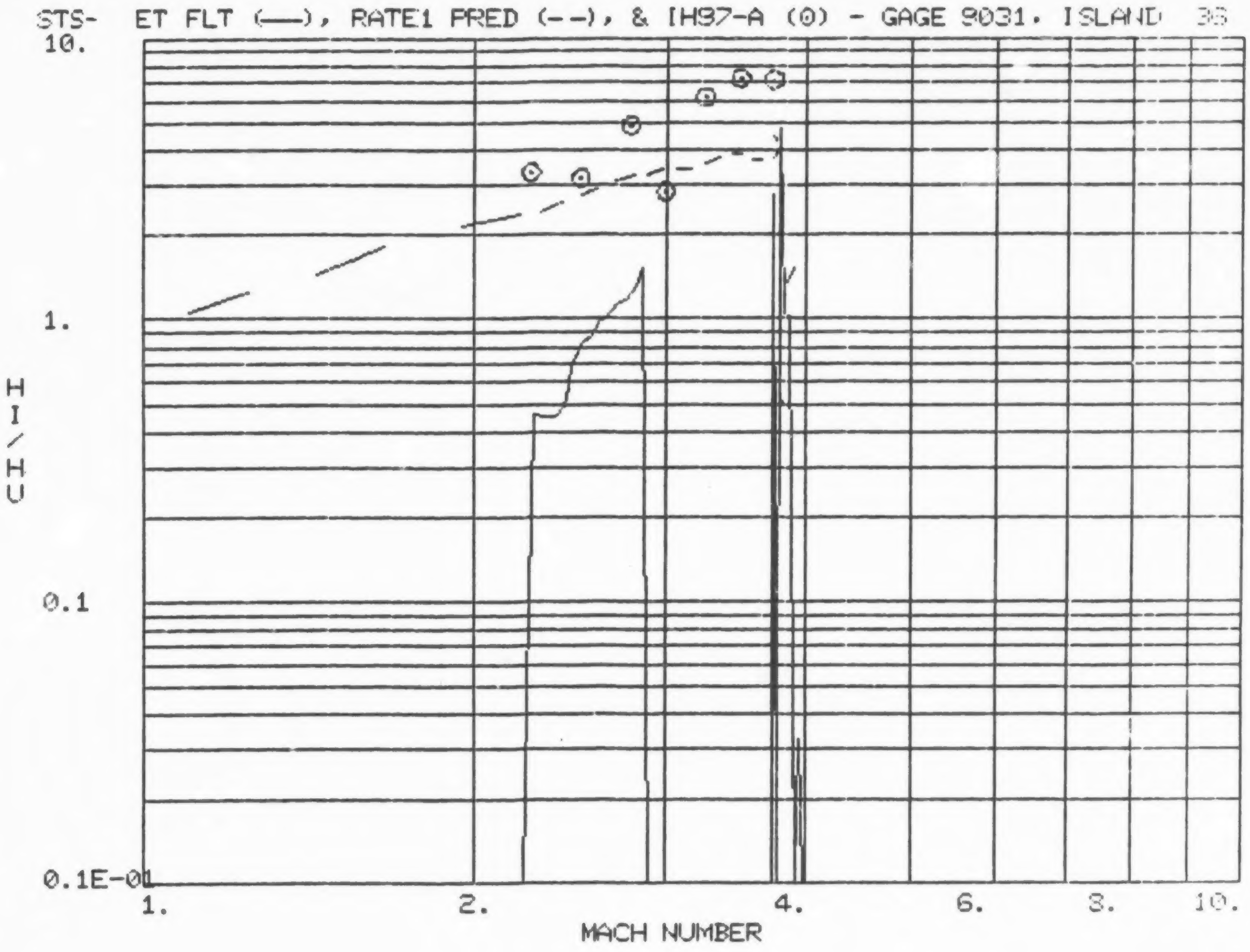
STS- ET FLT (——), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9031. ISLAND 36
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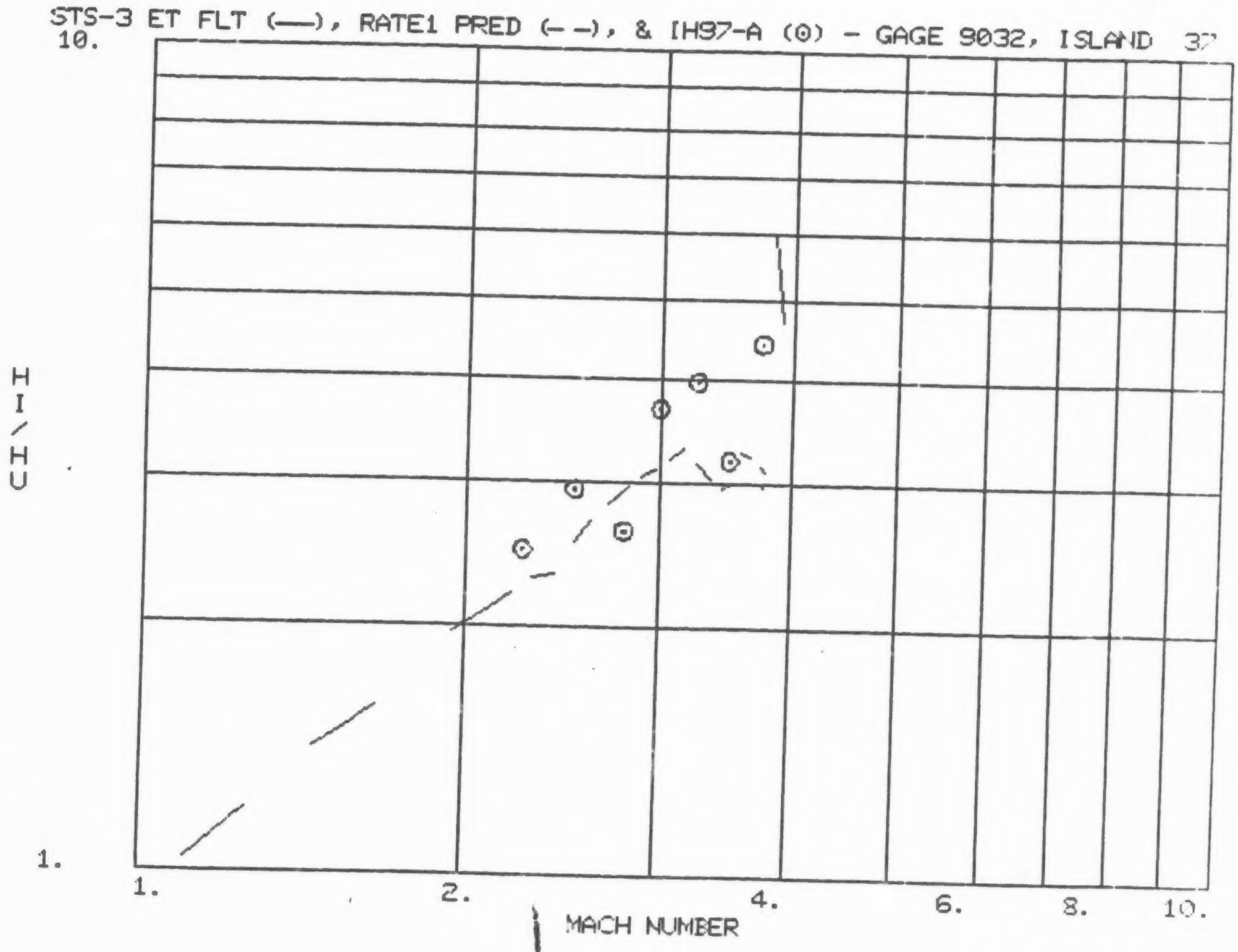
Fig. 3.24



STS-3 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9032, ISLAND 37
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Fig. 3.25

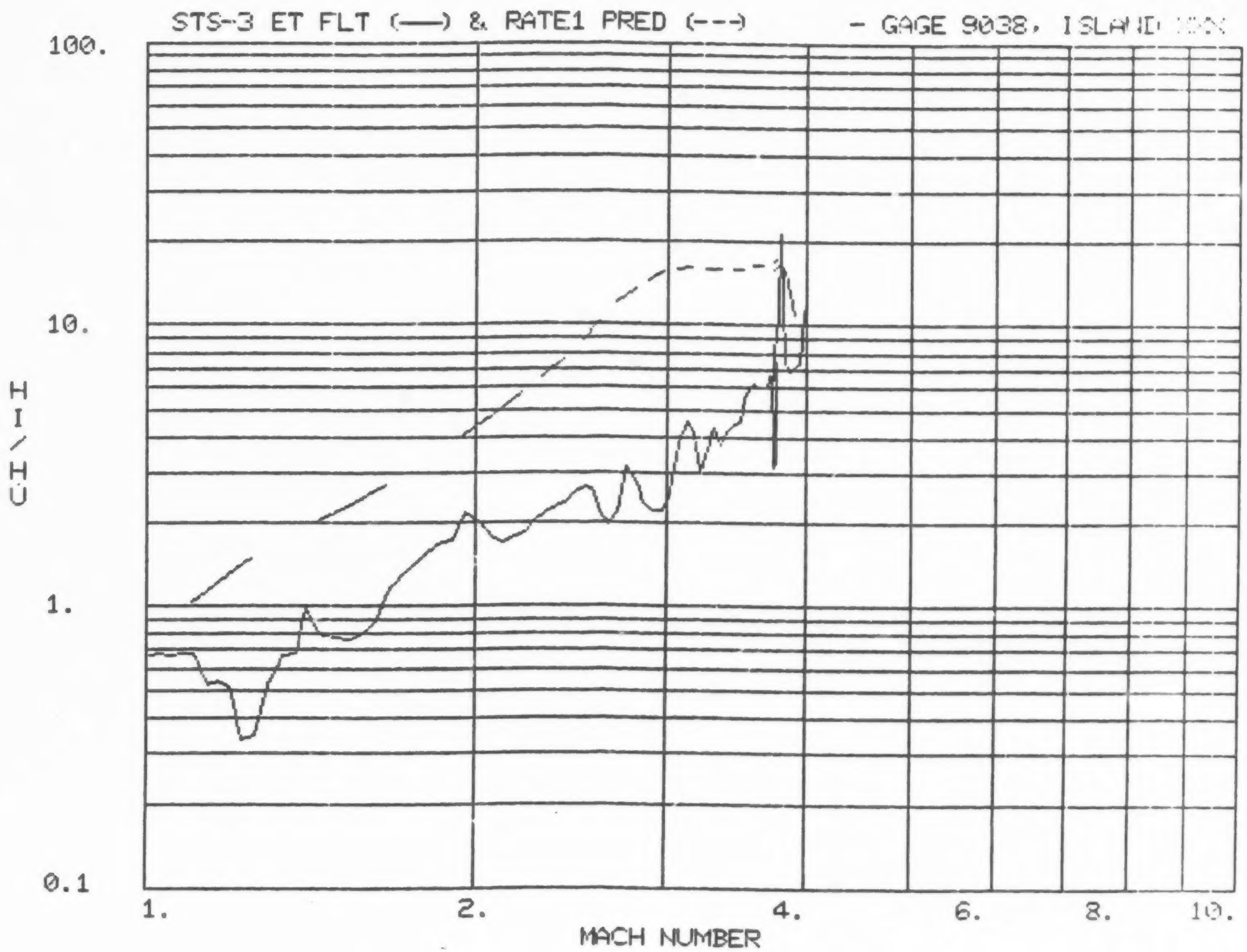
STS-3 ET FLT (—) & RATE1 PRED (---) - GAGE 9038, ISLAND
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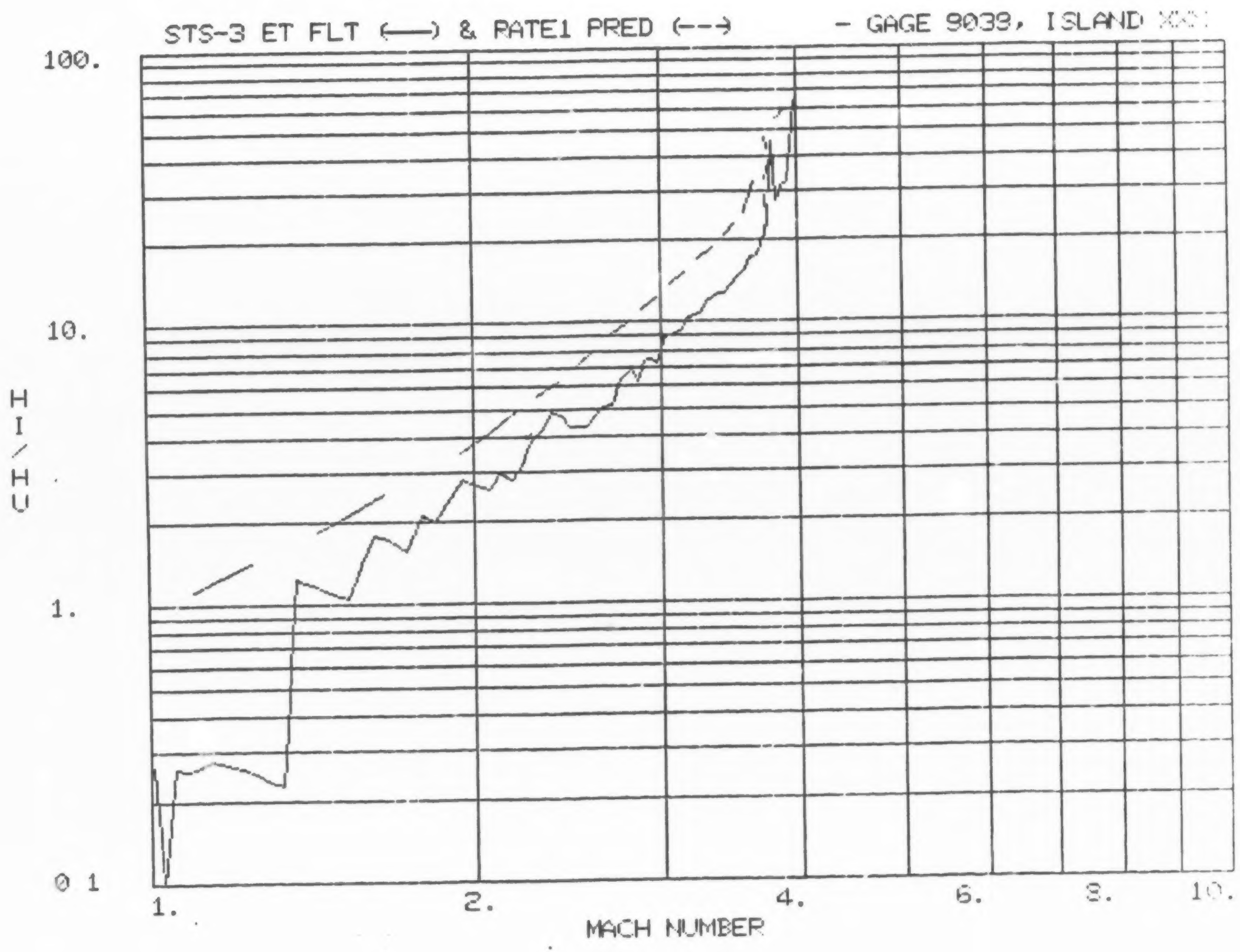
Fig. 3.26



STS-3 ET FLT (——) & RATE1 PRED (- - -) - GAGE 9033, ISLAND
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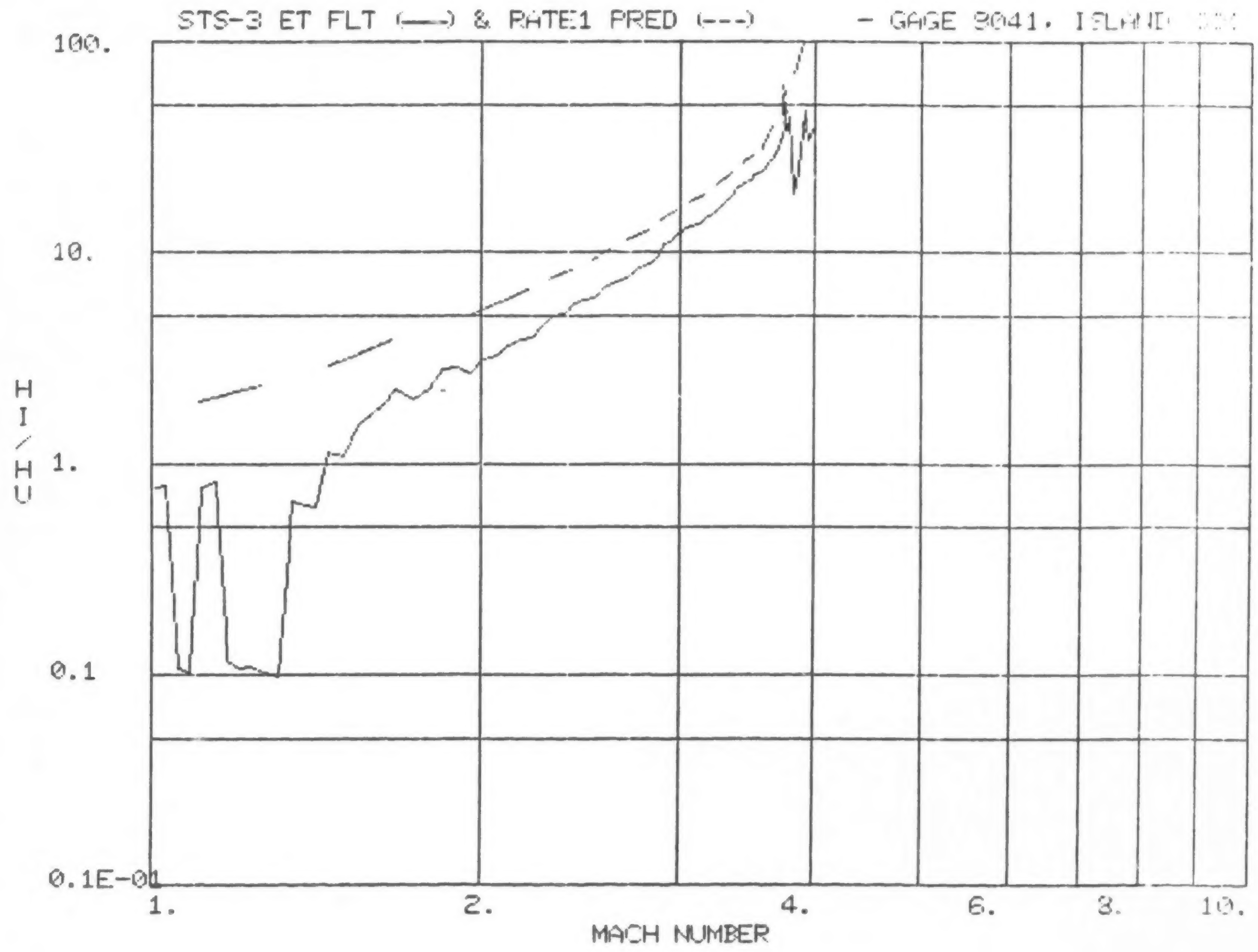
Fig. 3.27



STS-3 ET FLT (——) & RATE1 PRED (---)
- GAGE 3041. ISLAND
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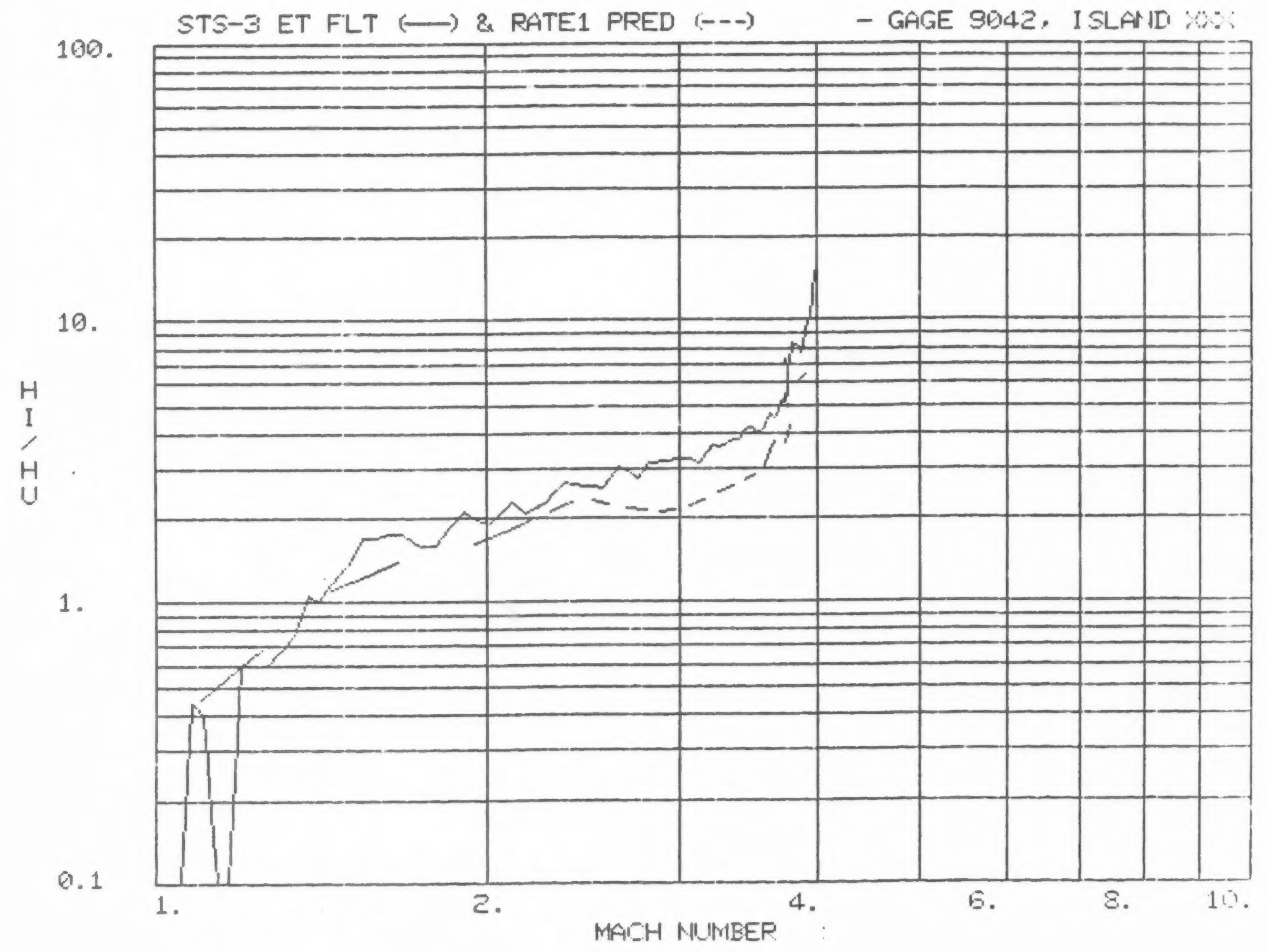
Fig. 3.28



STS-3 ET FLT (——) & RATE1 PRED (---) - GAGE 9042, ISLAND XXX
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Fig. 3.29

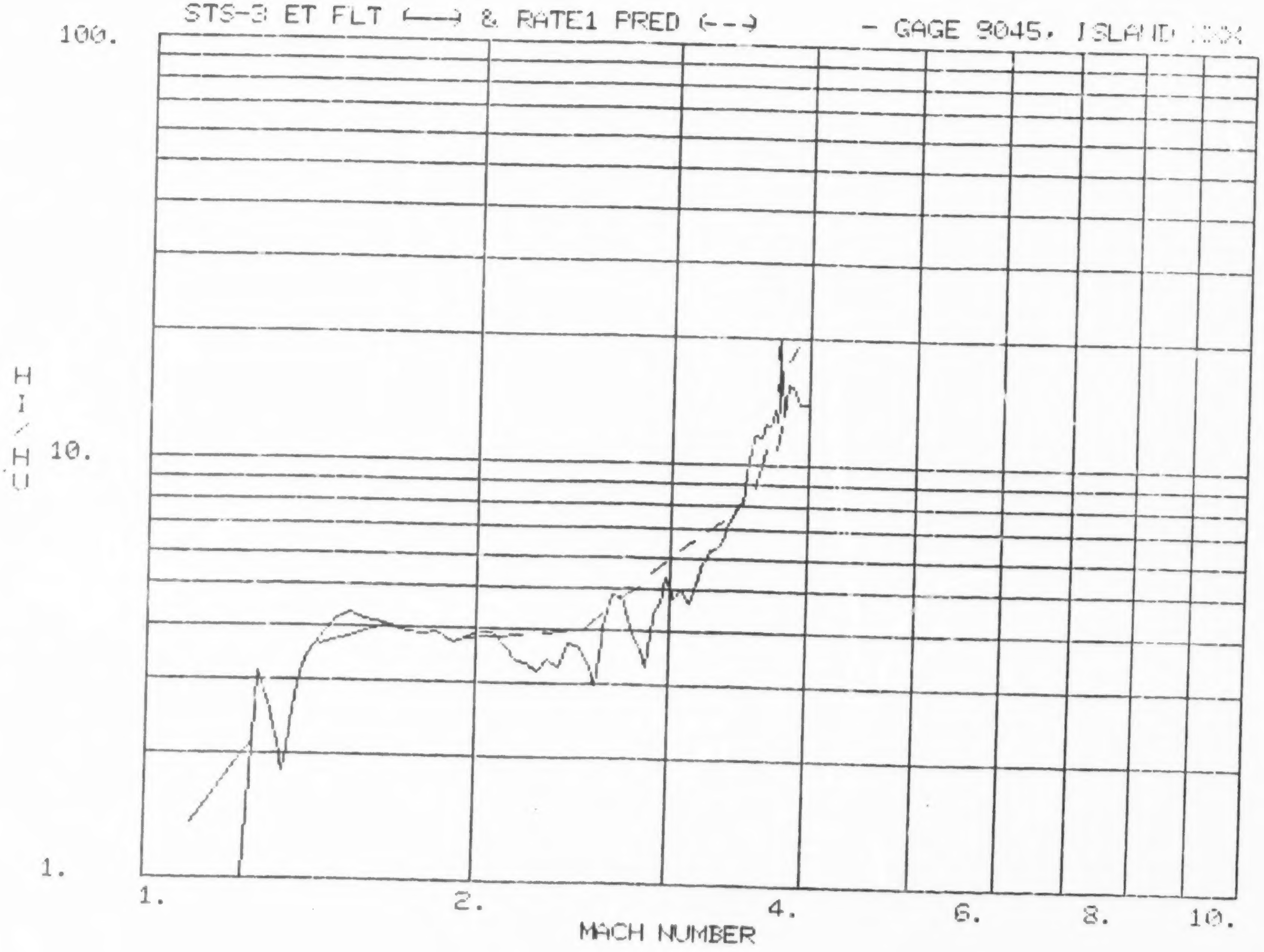
STS-3 ET FLT (——) & RATE1 PRED (- -) - GAGE 9045, ISLAND
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Fig. 3.30

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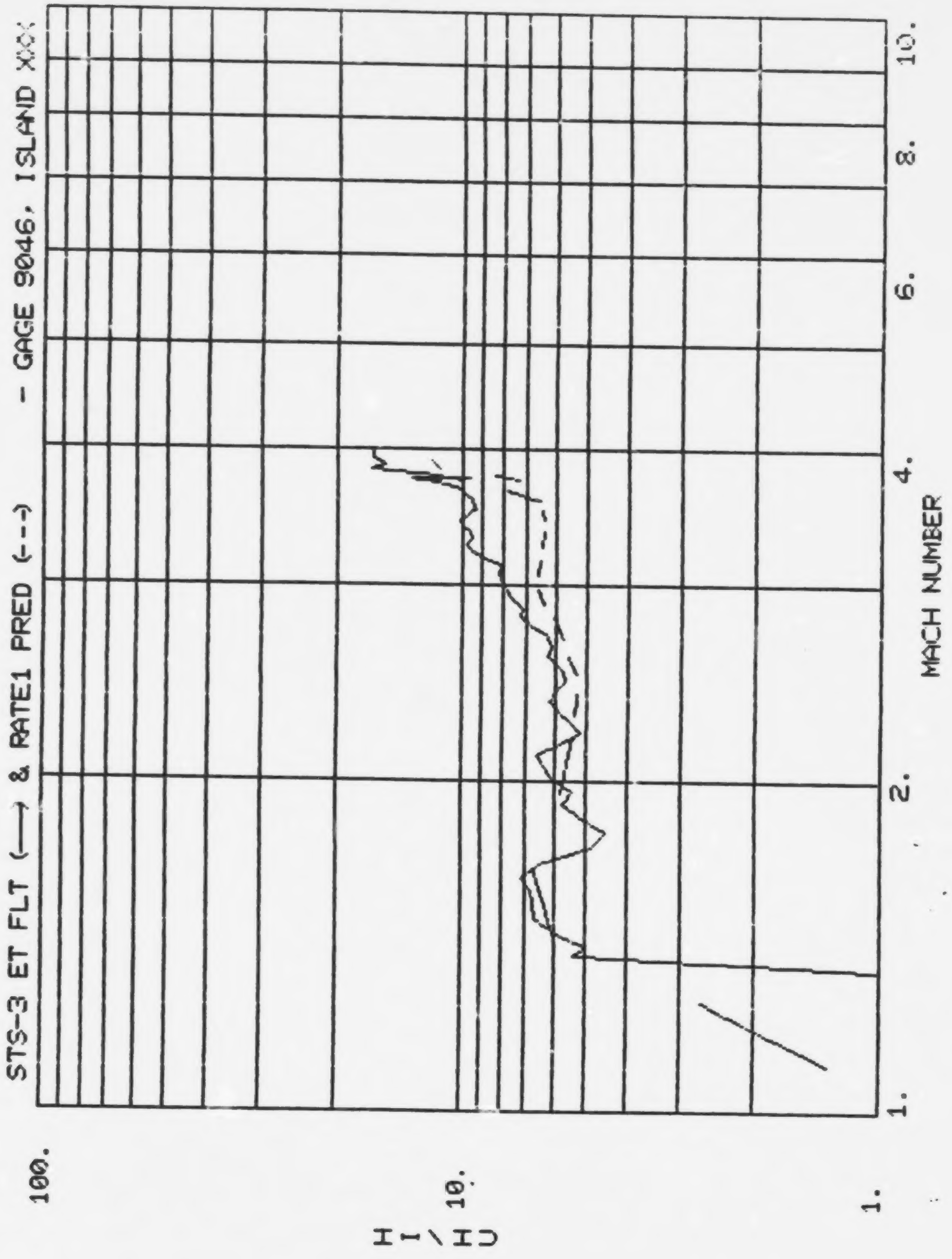

Fig. 3.31

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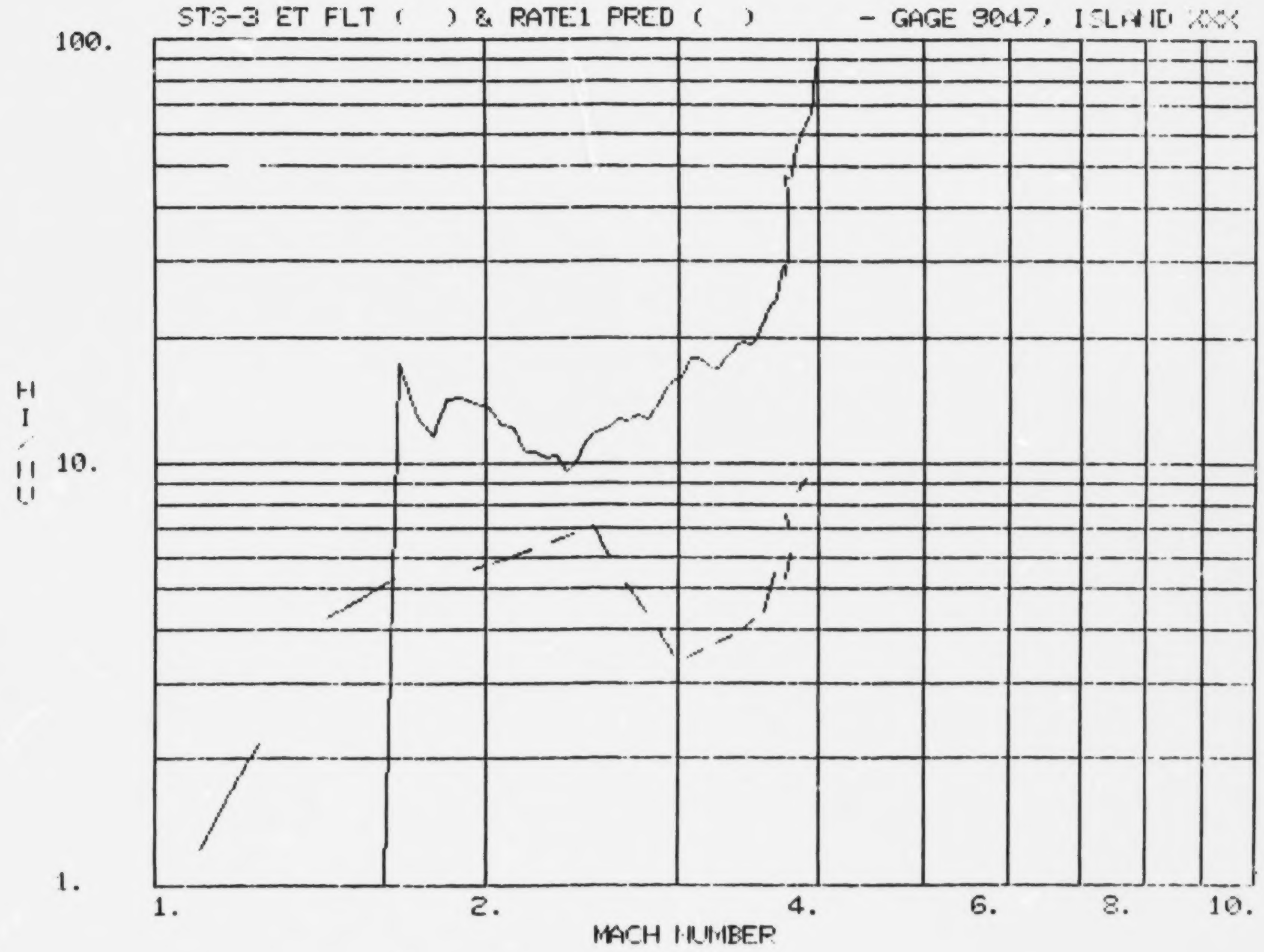

Fig. 3.32

REMTECH INC.

SET 4

STS-4 pp. 4.1 - 4.36

REMTECH INC.

Table 4.1 STS-4 DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9001A	350.0	180.0	Ind. Gage	40° Cone
T07R9004A	467.4	264.0	Island 2	LO2 Tank
T07R9005A	467.4	174.0	Island 1	LO2 Tank
T07R9007A	672.5	270.0	Island 6	LO2 Tank
T07R9008A	672.5	180.0	Island 5	LO2 Tank
T07R9010A	825.5	270.0	Island 8	LO2 Tank
T07R9011A	976.0	25.0	Island 18	Intertank
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9013A	1110.4	2.5	Island 17(3)	Intertank
T07R9014A	937.4	288.6	Island 16	Intertank
T07R9015A	956.2	270.0	Island 15	Intertank
T07R9016A	937.4	251.4	Island 14	Intertank
T07R9017A	948.5	180.0	Island 12	Intertank
T07R9018A	1098.5	2.5	Island 17(2)	Intertank
T07R9019A	1084.4	2.5	Island 17(1)	Intertank
T07R9020A	1147.4	358.0	Island 27	LH2 Barrel
T07R9021A	1030.1	270.0	Island 20	Intertank
T07R9022A	1073.8	180.0	Island 23	Intertank
T07R9023A	1130.3	0.0	Island 26	LH2 Barrel
T07R9025A	1489.0	264.4	Island 29	LH2 Barrel
T07R9026A	1489.0	172.5	Island 28	LH2 Barrel
T07R9027A	2017.0	5.6	Island 33	LH2 Barrel
T07R9028A	2057.0	5.6	Island 35	LH2 Barrel
T07R9029A	2002.5	168.7	Island 32	LH2 Barrel
T07R9030A	2038.97	356.3	Island 34	LH2 Barrel
T07R9031A	2057.0	276.0	Island 36	LH2 Barrel
T07R9032A	2057.0	340.6	Island 37	LH2 Barrel
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2100.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2035.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

REMTECH INC.

Table 4.2 STS-4 ET INTERFERENCE FACTORS FROM THE IH-97A WIND TUNNEL DATA BASE

GAGE NO.	IH97A NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
9001	5029	0.781	0.964	1.088	1.801	1.349	0.703	0.269	0.196
9004	5031	1.016	0.967	0.962	1.023	0.971	0.975	0.906	0.952
9005	5030	0.947	0.939	0.930	0.946	0.946	0.968	0.882	0.942
9007	5033	0.919	0.906	0.891	1.029	0.908	0.940	0.794	0.946
9008	5032	1.133	1.130	1.120	1.182	1.074	1.116	1.050	1.062
9010	5034	0.390	0.507	0.460	0.420	0.419	0.309	0.276	0.302
9011	5042	1.408	1.274	0.941	0.793	1.489	—	1.355	1.385
9013	5041	—	—	—	3.892	3.415	3.565	4.863	—
9014	5038	3.657	3.373	4.203	4.650	5.523	6.081	6.264	7.202
9015	5258	5.590	7.321	8.232	8.679	9.210	9.216	12.669	13.006
9016	5036	3.954	4.155	4.021	4.444	4.878	5.684	5.689	5.873
9017	5035	0.655	0.650	0.709	0.773	0.844	0.752	0.819	0.863
9018	5039	2.992	3.585	3.557	3.383	3.221	3.395	3.114	3.628
9019	5040	2.606	3.124	2.790	2.554	2.342	2.414	2.084	2.593
9020	5250	2.751	3.122	3.716	4.739	5.069	5.845	6.042	5.830
9021	5043	0.204	0.395	0.505	0.686	1.015	—	1.409	1.403
9022	5044	1.534	1.232	0.955	0.709	0.778	0.738	0.784	0.886
9023	5249	3.109	3.485	3.883	3.692	4.234	3.101	3.914	3.493
9024	5251	1.104	1.243	1.392	1.663	1.875	1.972	2.005	2.032
9025	5046	—	1.073	0.859	0.770	0.770	0.409	0.377	0.436
9026	5045	0.683	0.879	0.866	0.883	0.799	0.901	0.725	0.780
9027	5048	1.093	1.367	1.445	1.627	1.973	2.992	1.282	0.911
9028	5050	1.082	1.279	1.395	1.802	2.421	2.338	2.626	2.347
9029	5047	—	0.500	0.460	0.539	0.213	0.213	0.016	0.276
9030	5049	1.967	1.816	2.618	2.992	2.594	4.222	4.060	2.194
9031	5051	3.826	3.378	5.073	5.471	6.129	4.188	3.453	7.661
9032	5052	2.327	2.799	3.008	3.107	3.050	3.408	2.609	4.887
9033	5252	1.400	1.133	1.601	1.340	1.503	1.480	0.997	0.996

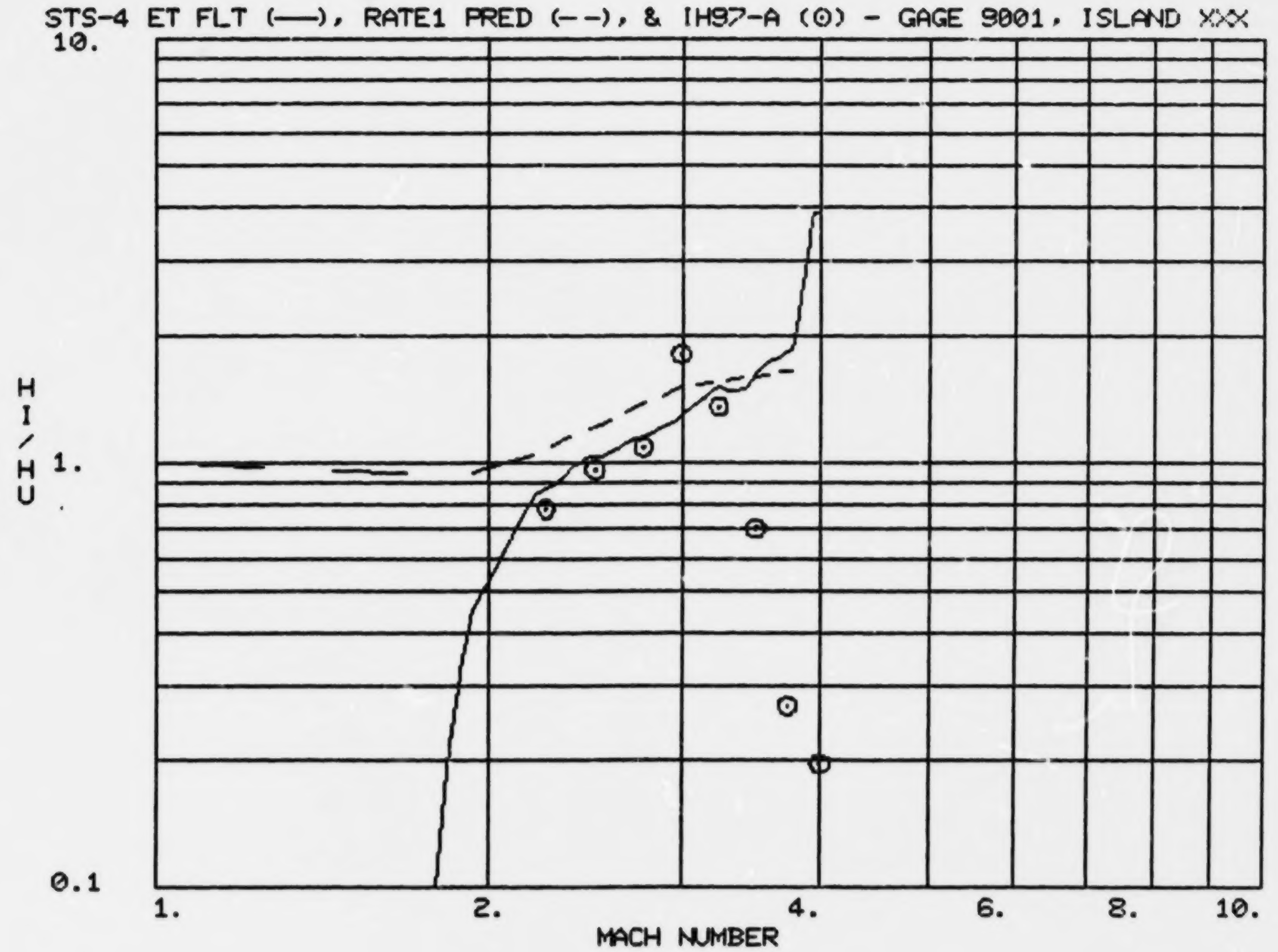
STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9001, ISLAND XXX
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Fig. 4.1

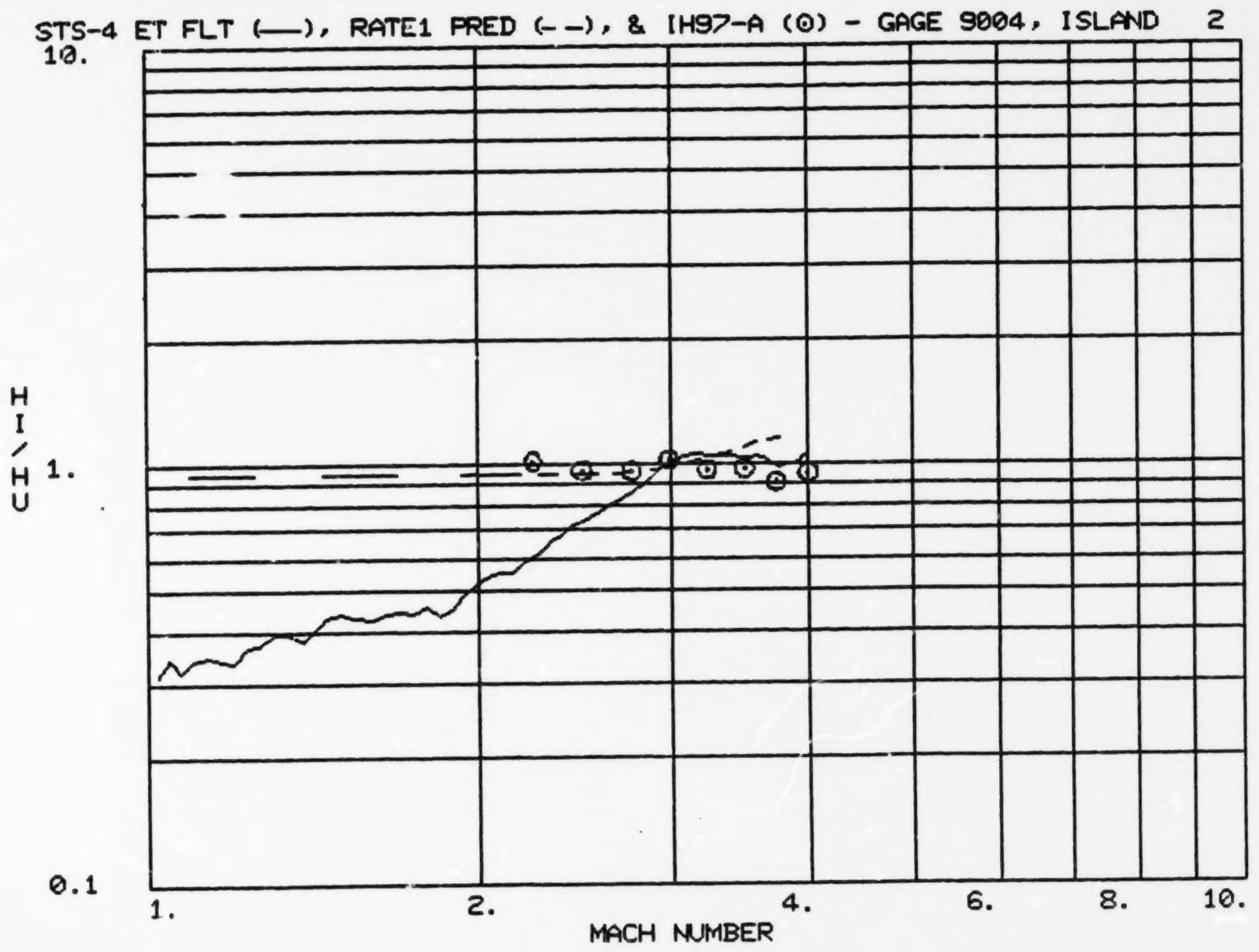
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Fig. 4.2

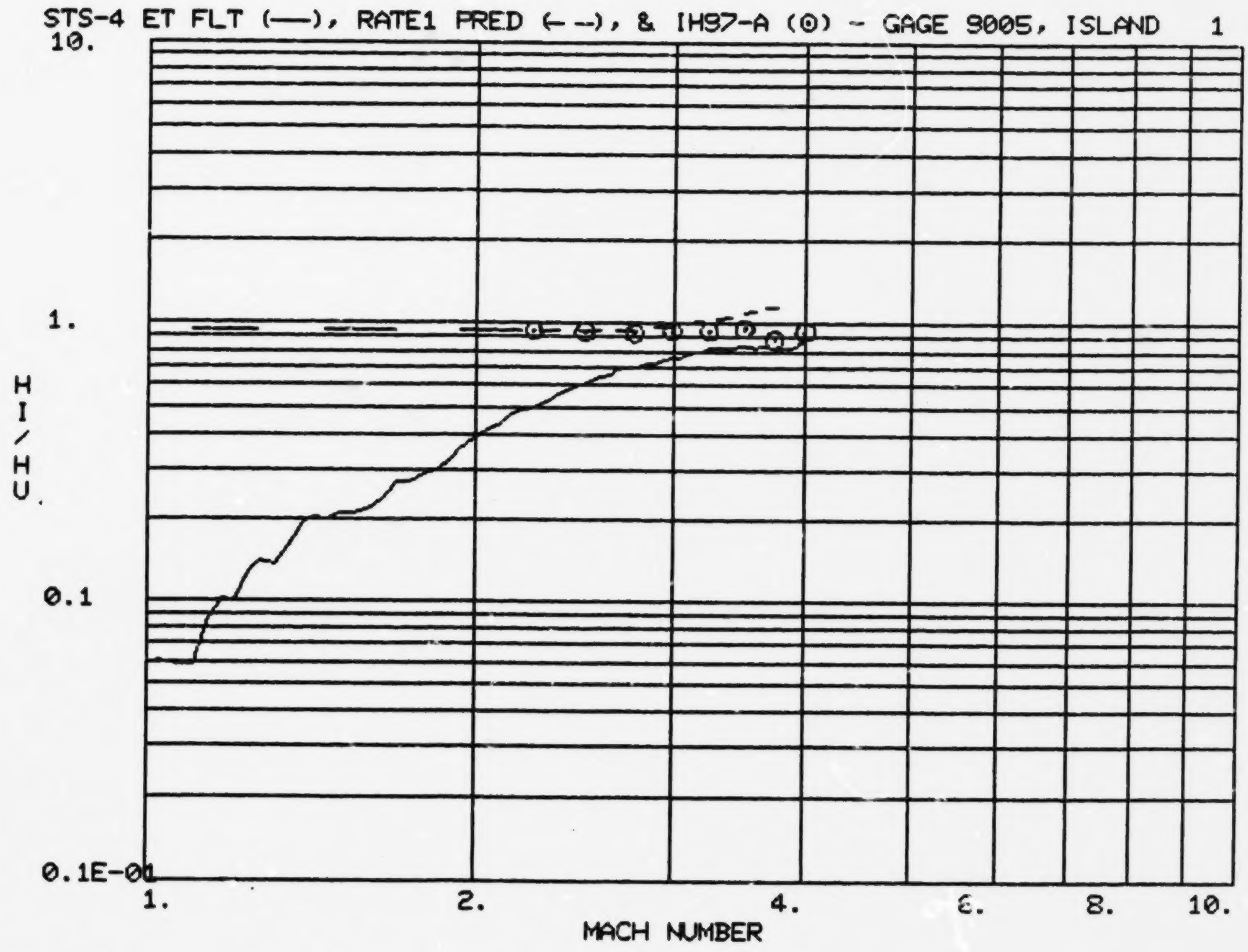
STS-4 ET FLT (—), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9005, ISLAND 1
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Fig. 4.3

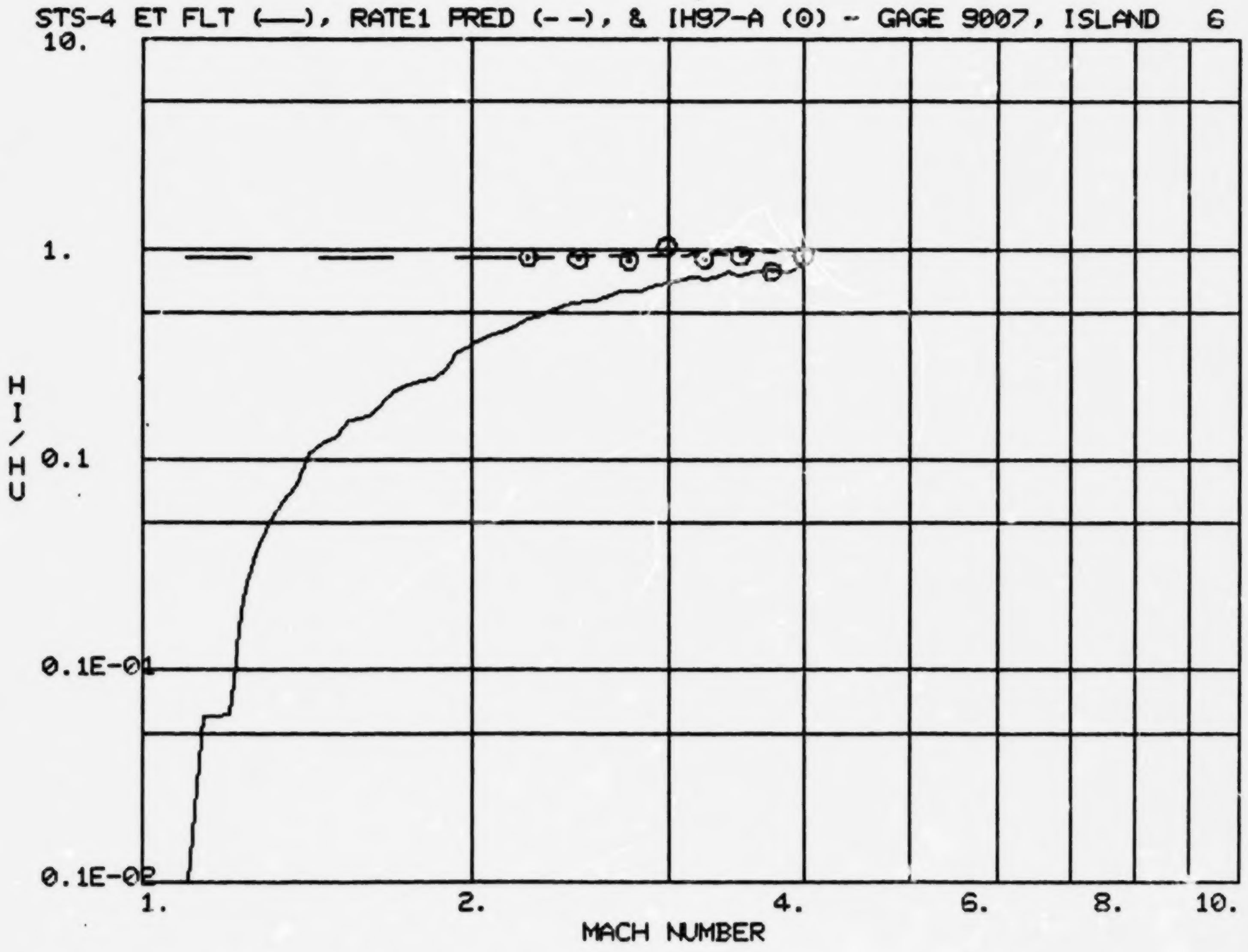
STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9007, ISLAND 6
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Fig. 4.4

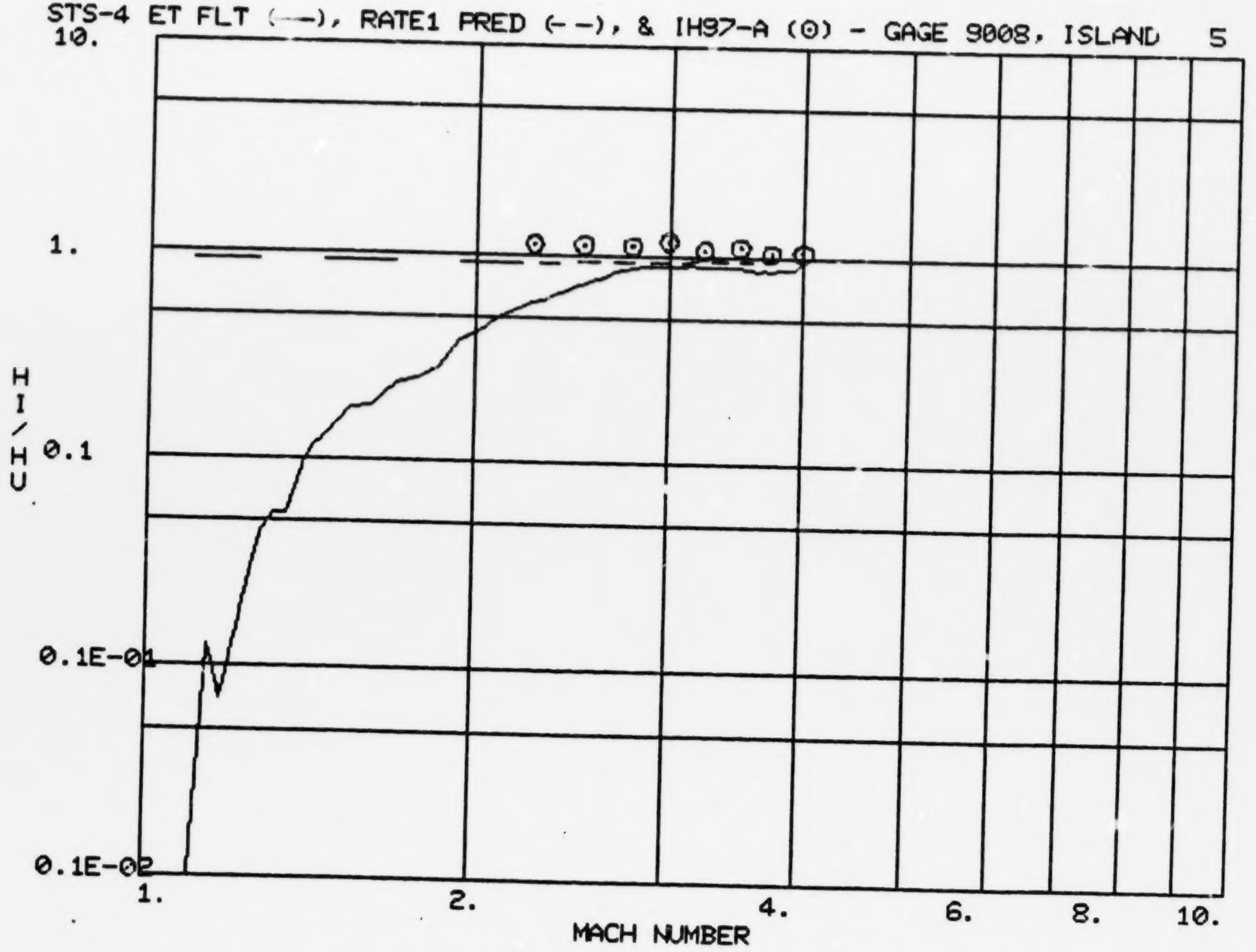
STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9008, ISLAND 5
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Fig. 4.5

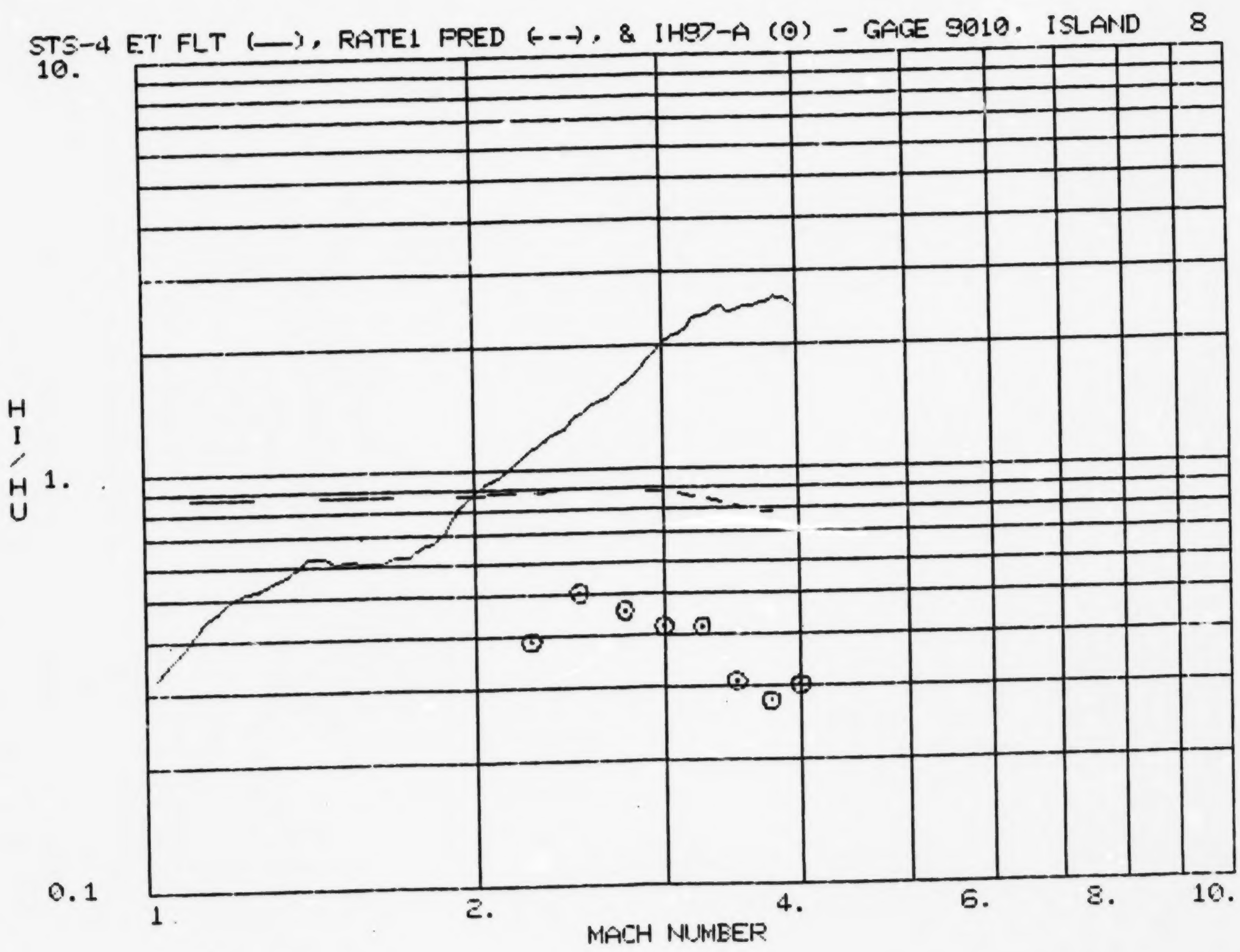
STS-4 ET FLT (——), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9010. ISLAND 8
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Fig. 4.6

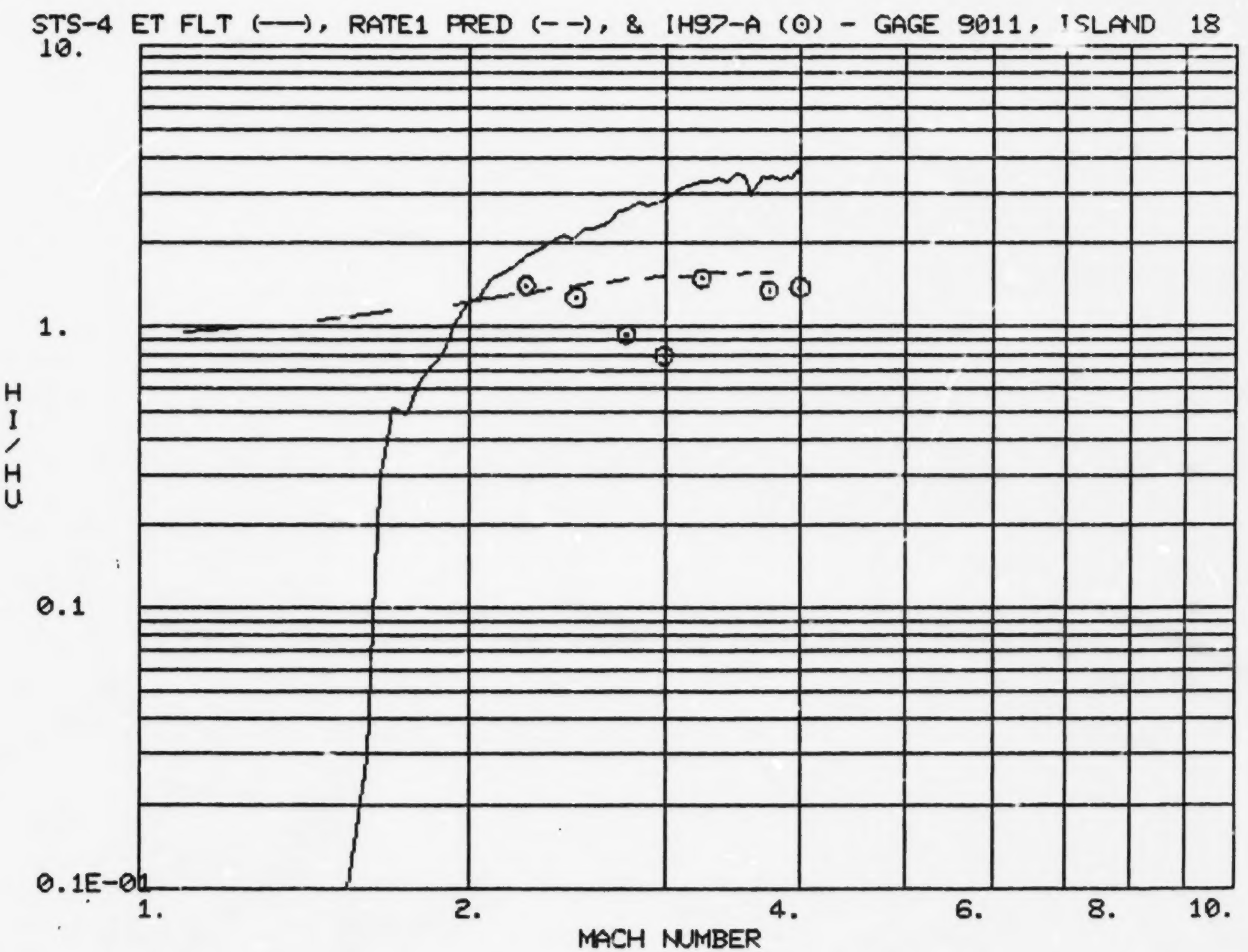
STS-4 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9011, ISLAND 18
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Fig. 4.7

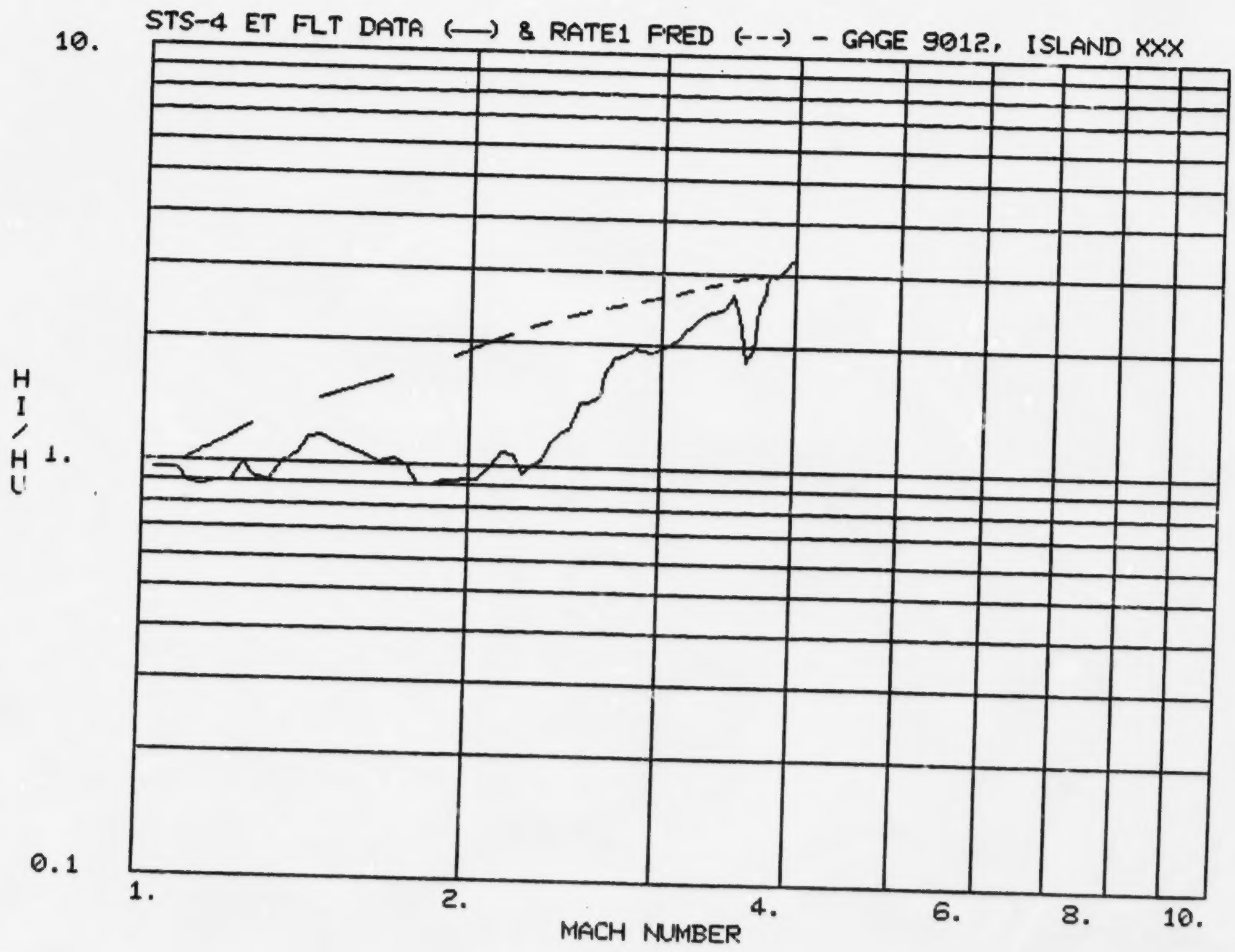
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Fig. 4.8

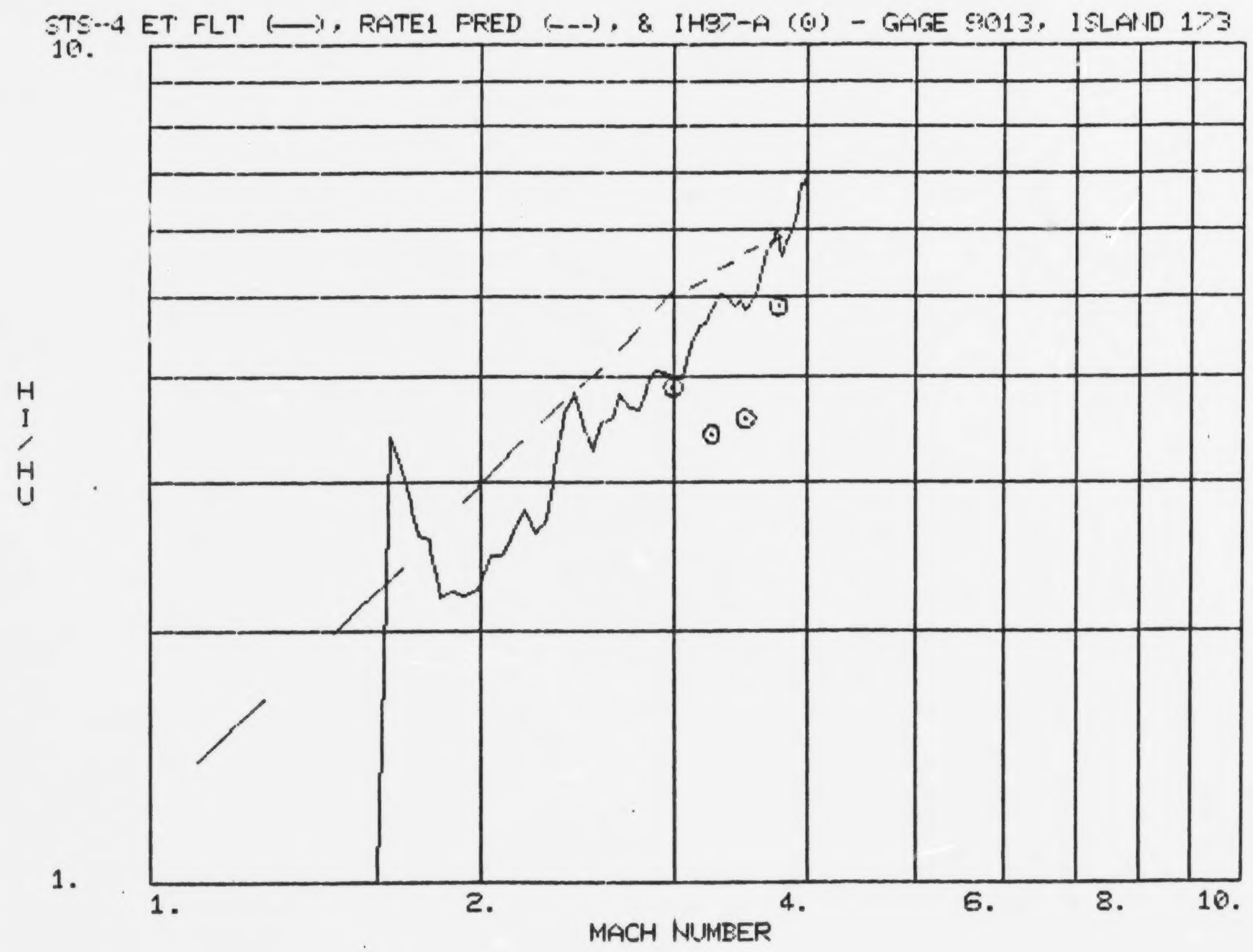
STS-4 ET FLT (——), RATE1 PRED (---), & IH37-A (⊙) - GAGE 9013, ISLAND 173
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Fig. 4.9

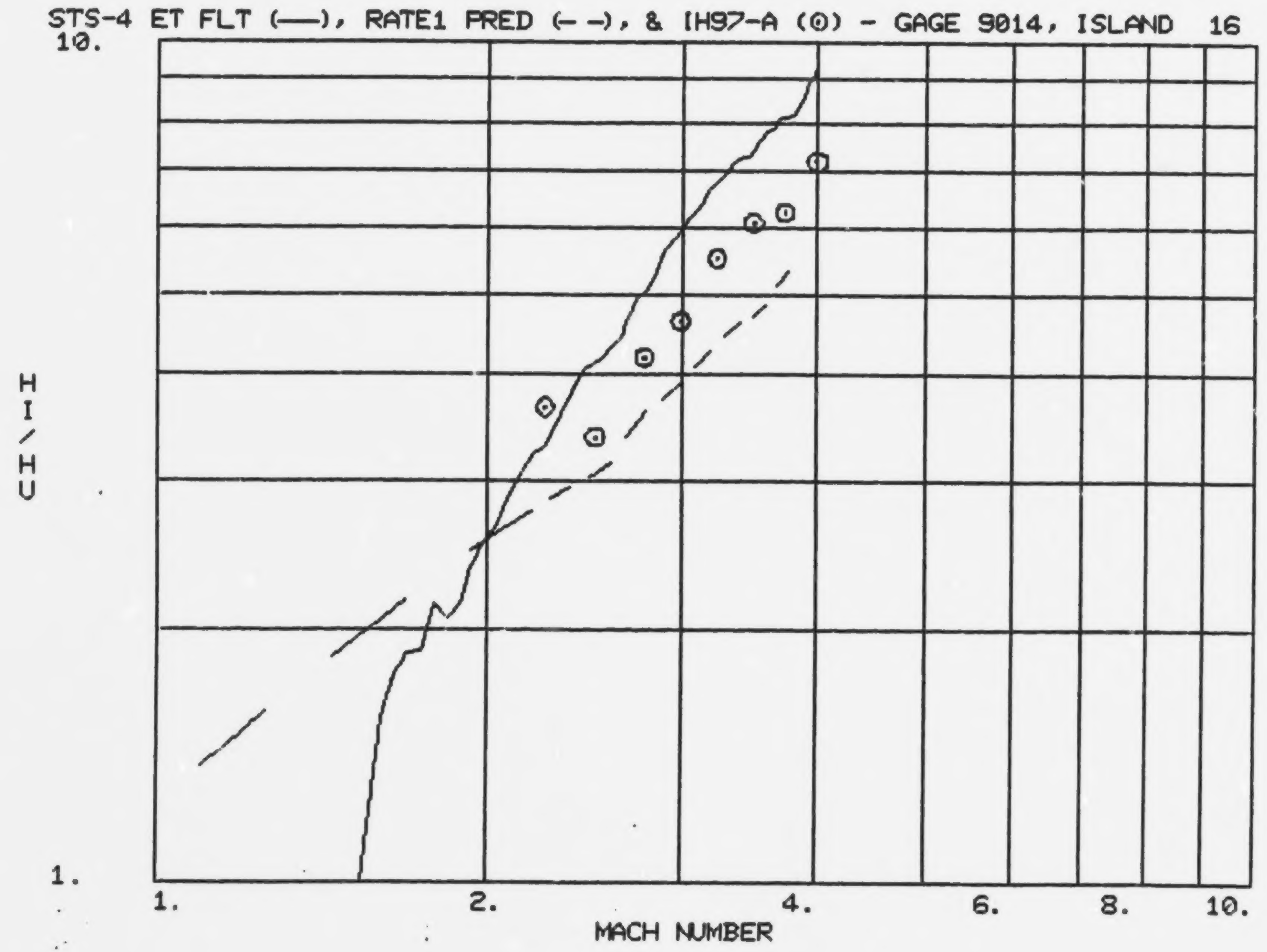
STS-4 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9014, ISLAND 16
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Fig. 4.10

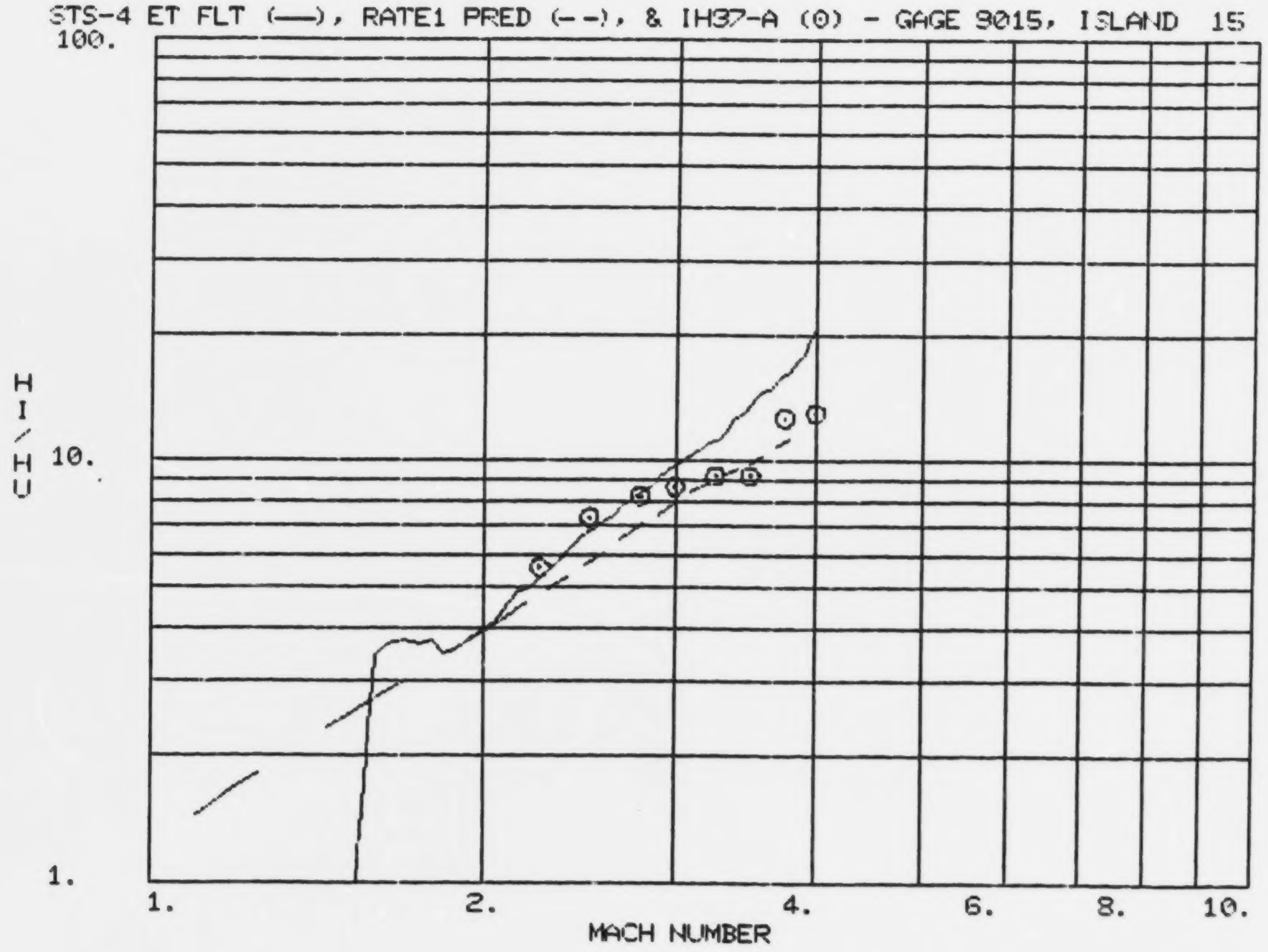
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Fig. 4.11

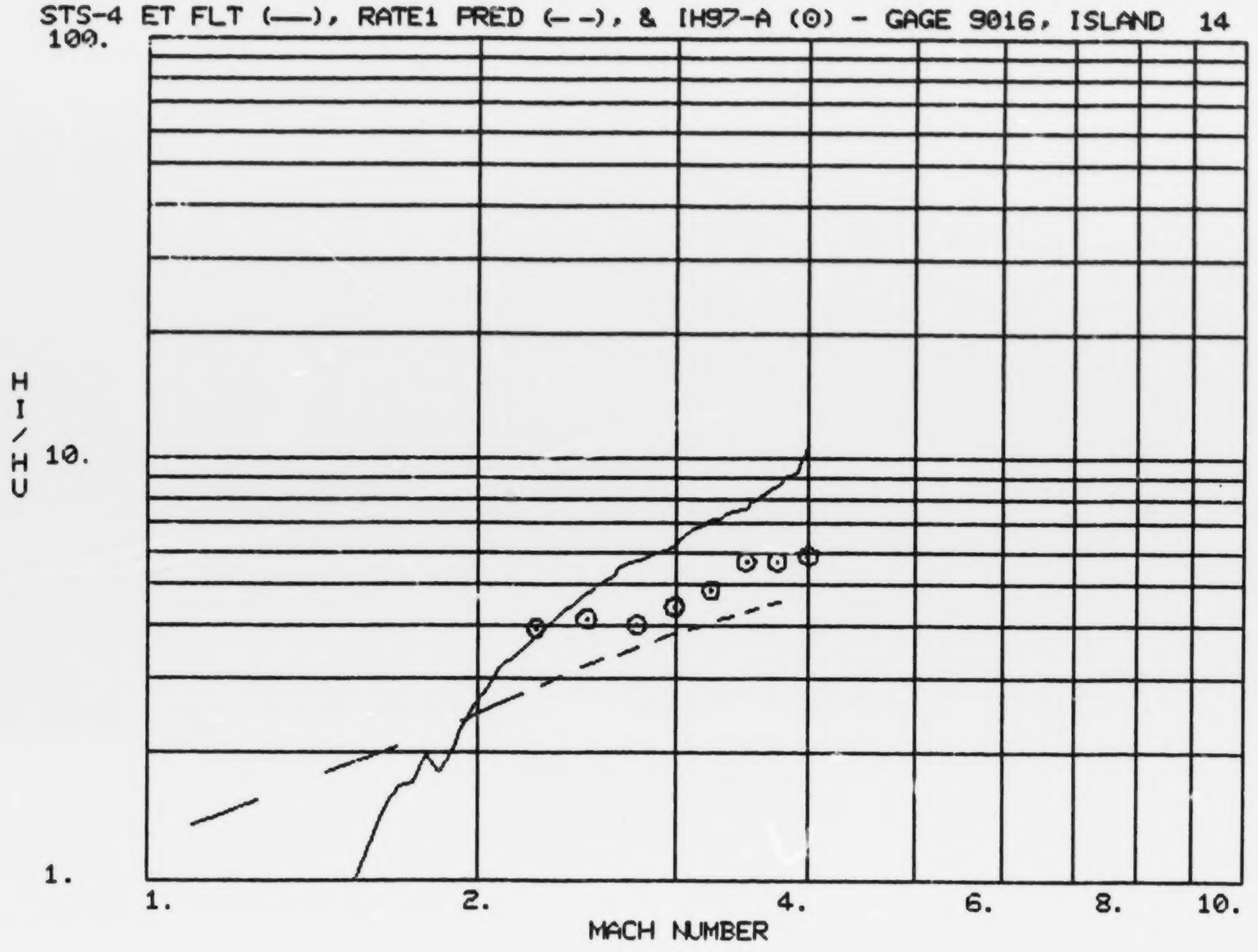
STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9016, ISLAND 14
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Fig. 4.12

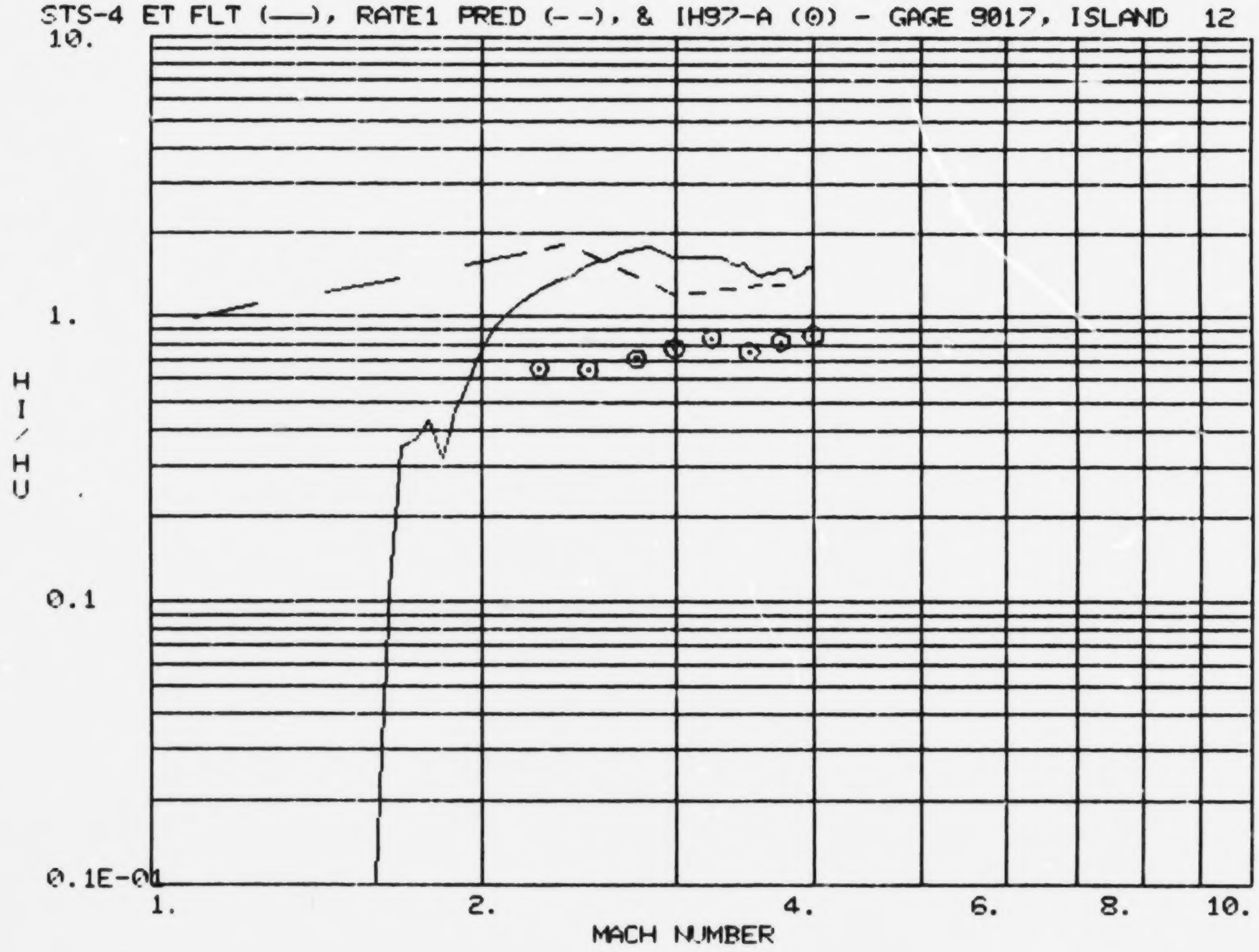
STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9017, ISLAND 12
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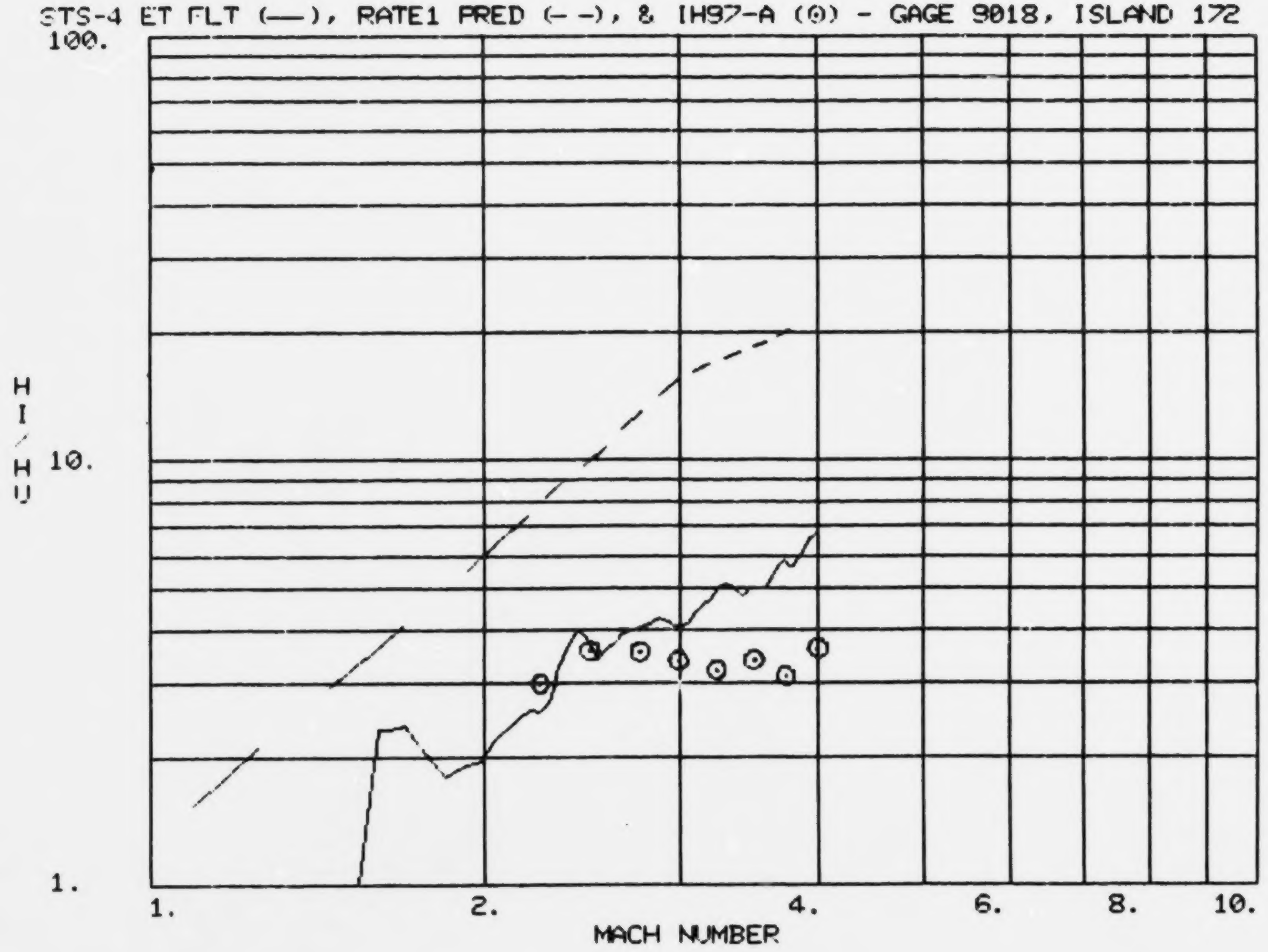
Fig. 4.13



STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9018, ISLAND 172
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Fig. 4.14

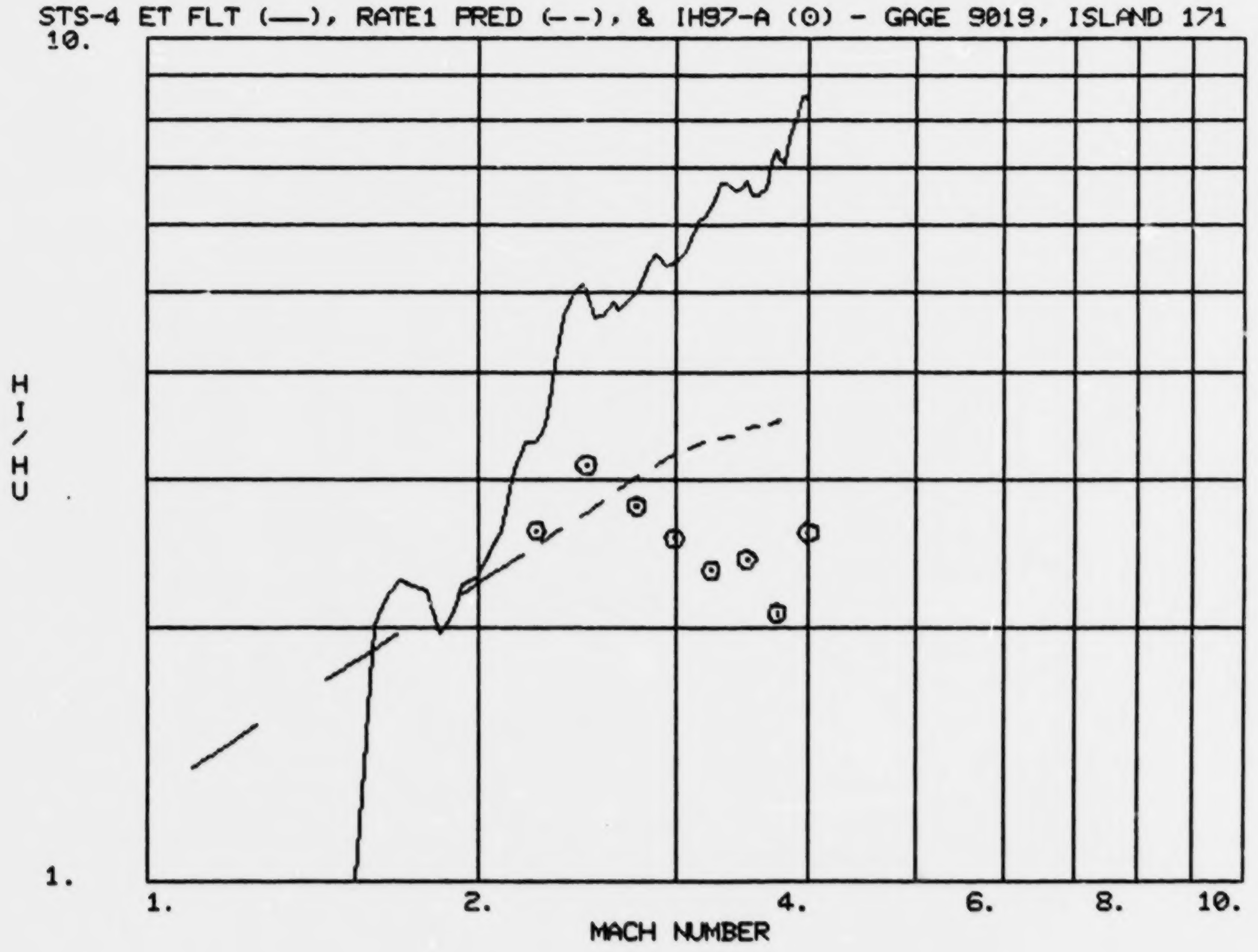
STS-4 ET FLT (—), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9019, ISLAND 171
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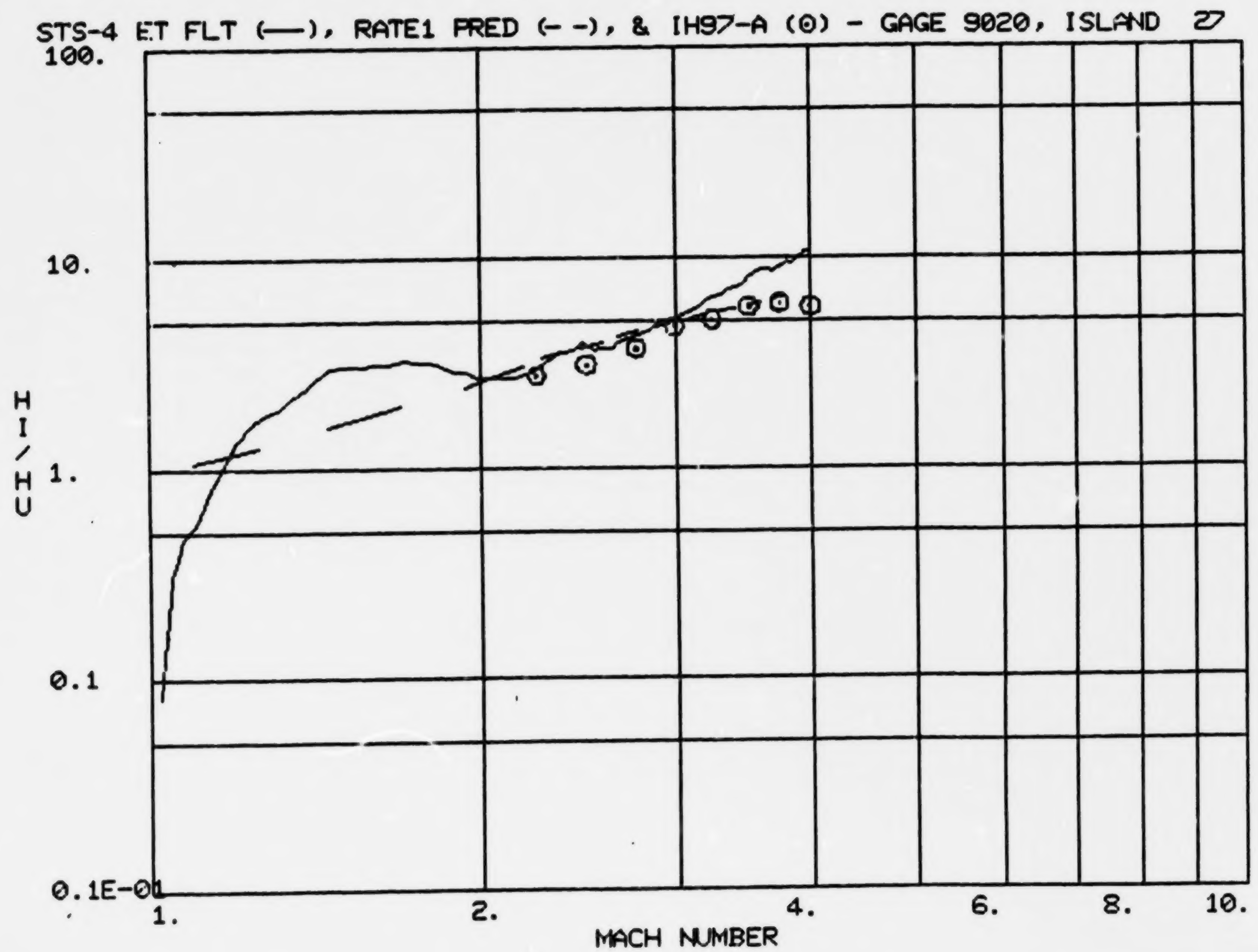
Fig. 4.15


STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9020, ISLAND 27
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MACH NUMBER

Fig. 4.16

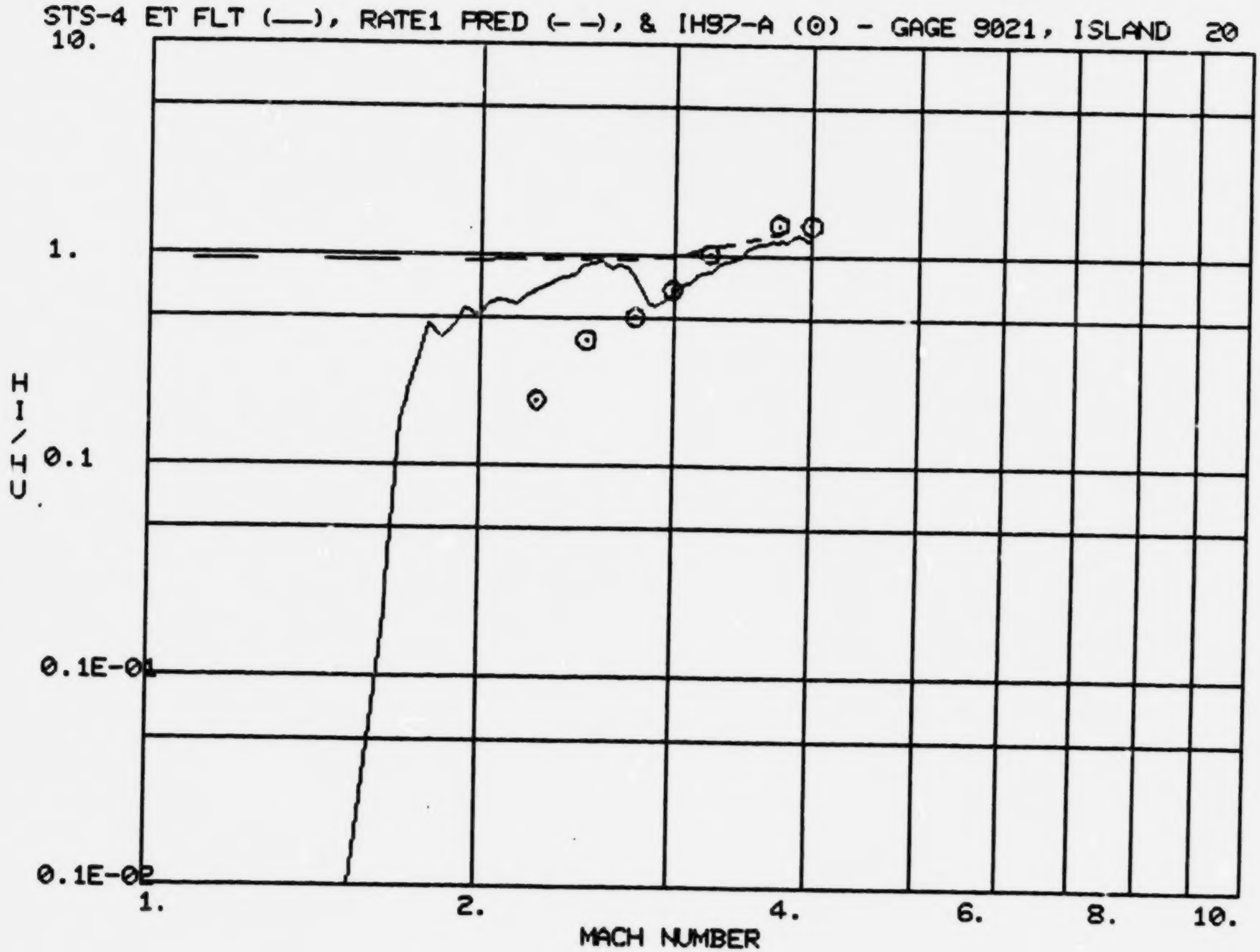
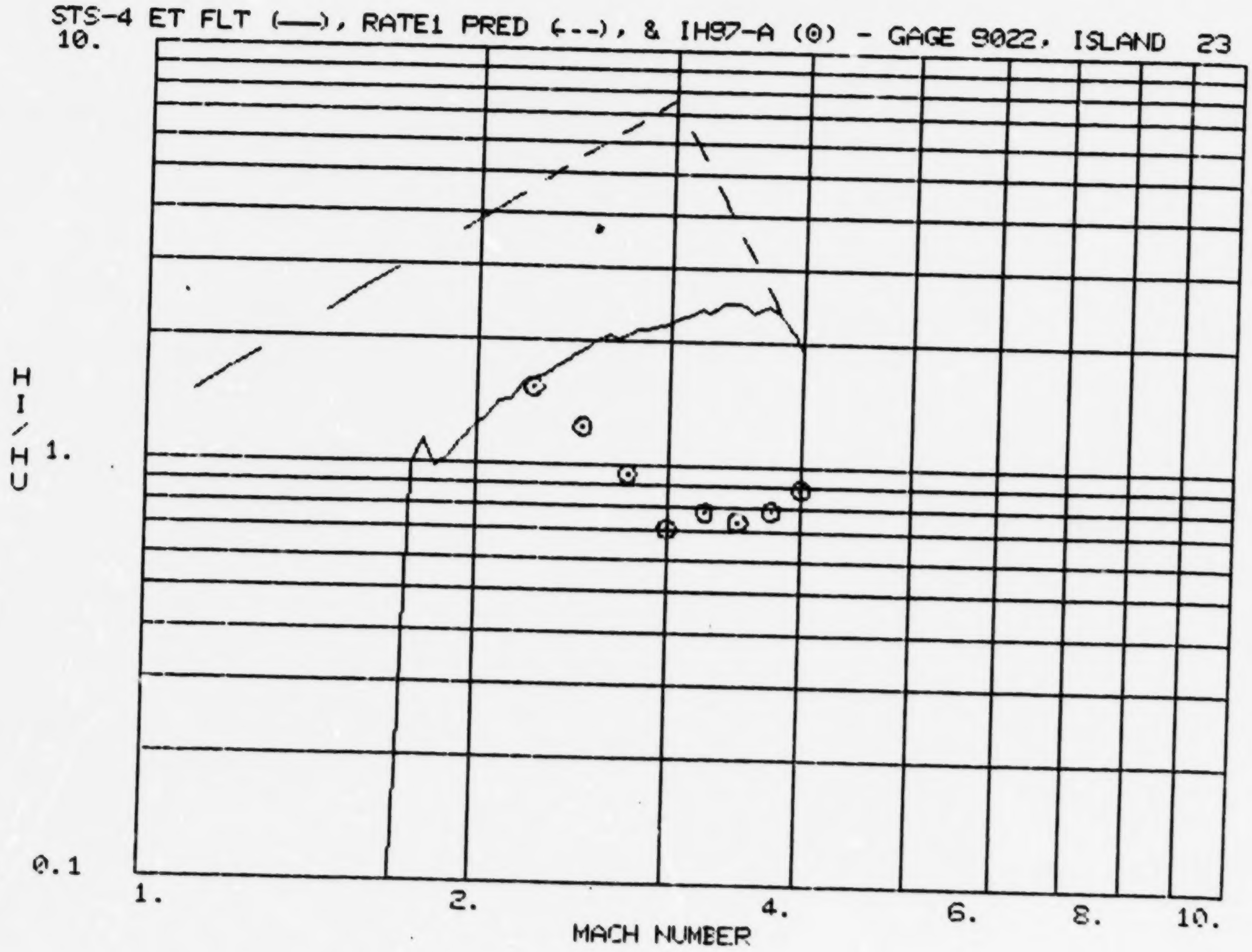

STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9021, ISLAND 20
10.
1.
0.1
0.1E-01
0.1E-02
H I / H U
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.17



STS-4 ET FLT (—), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9022, ISLAND 23
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1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.18

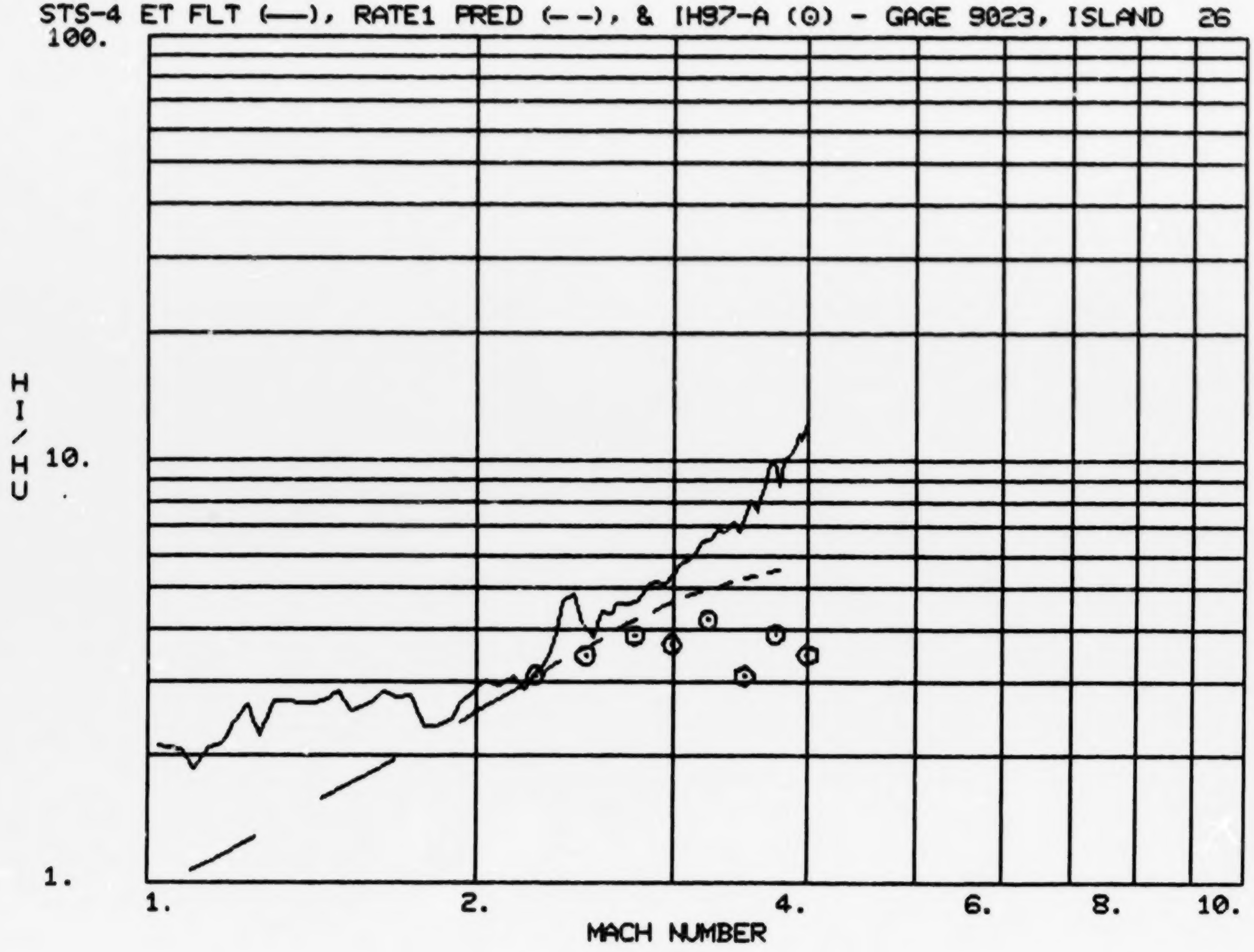
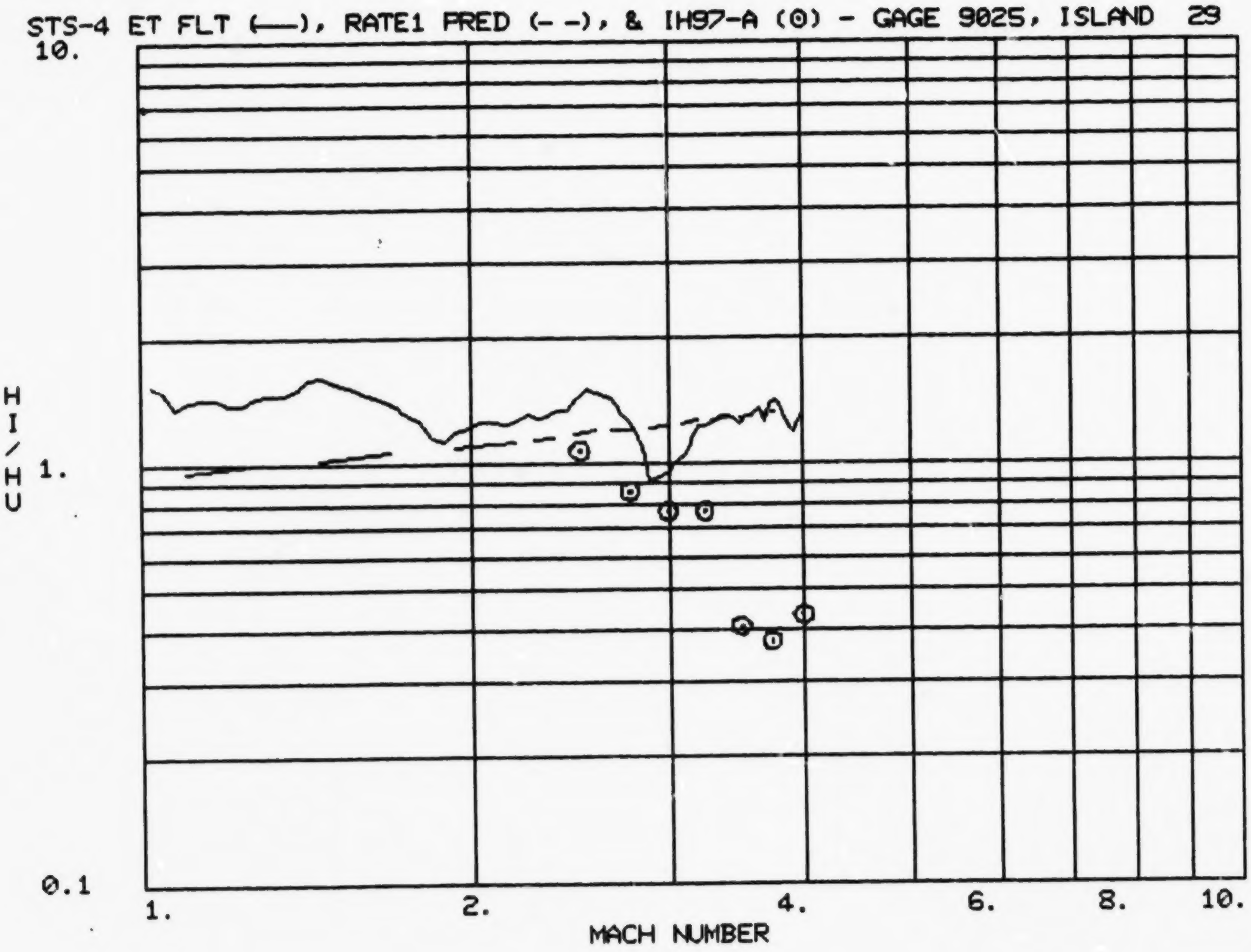

STS-4 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9023, ISLAND 26
100.
10.
1.
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.19



STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9025, ISLAND 29
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1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.20

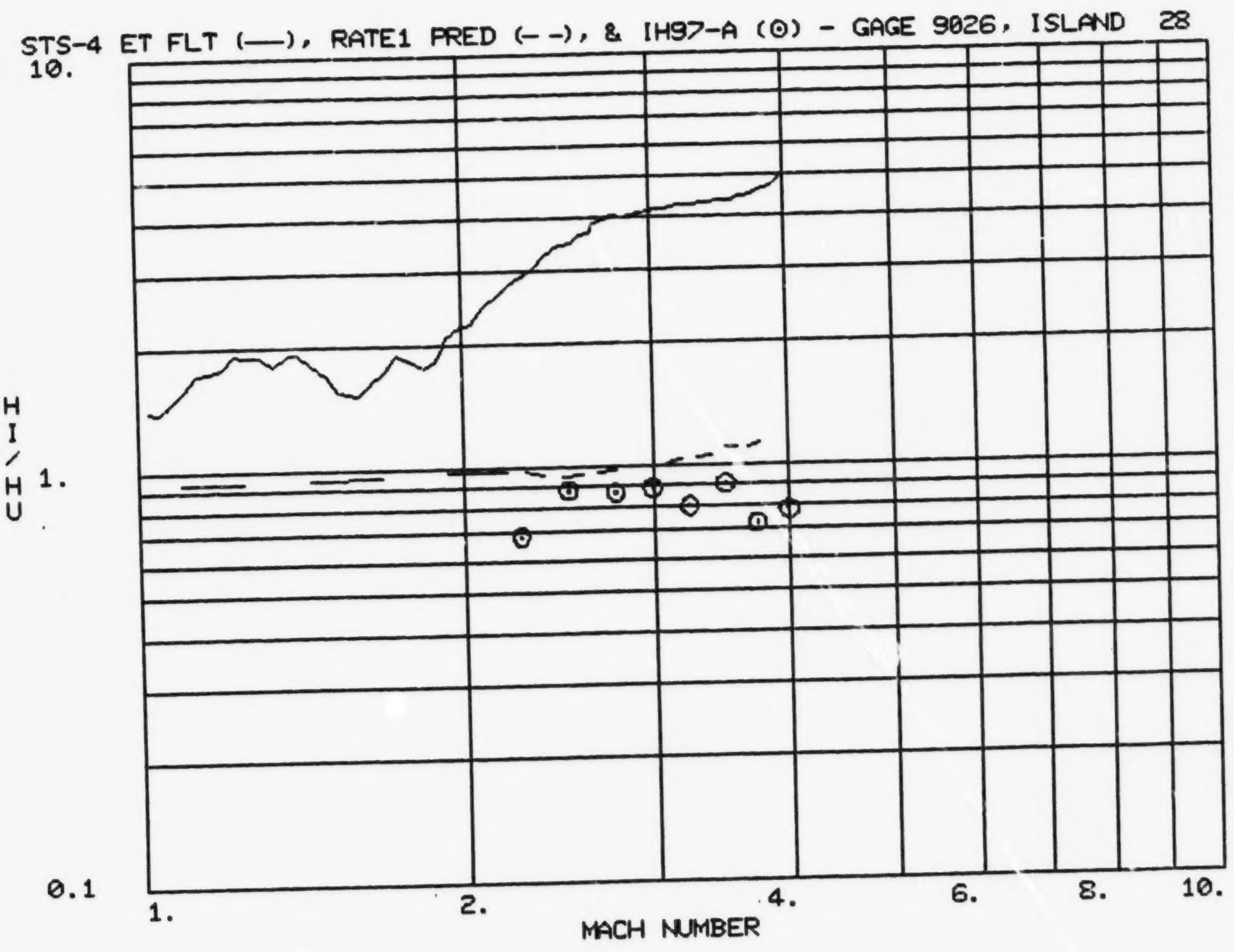
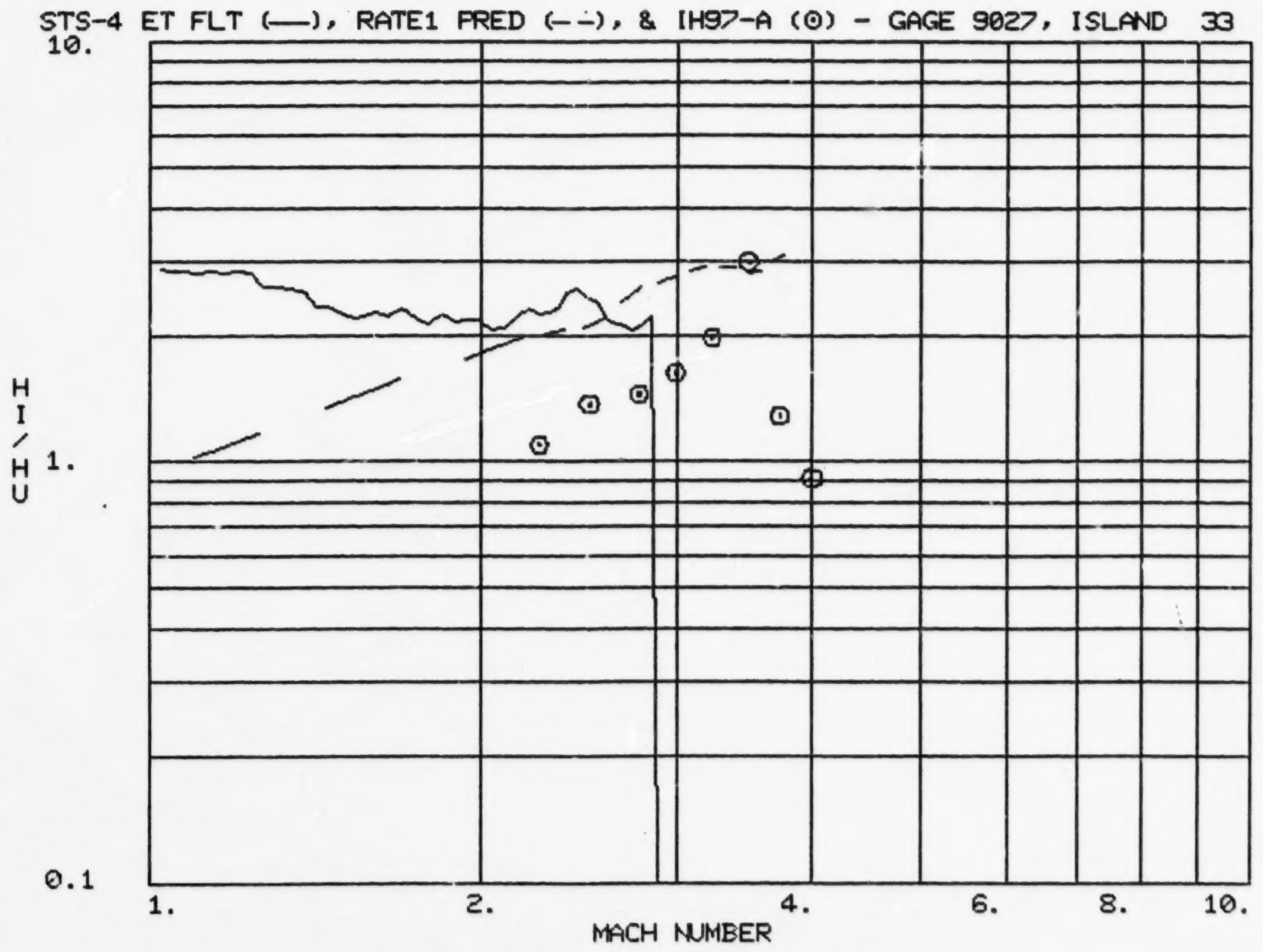

STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9026, ISLAND 28
10.
1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.21



STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9027, ISLAND 33
10.
1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.22

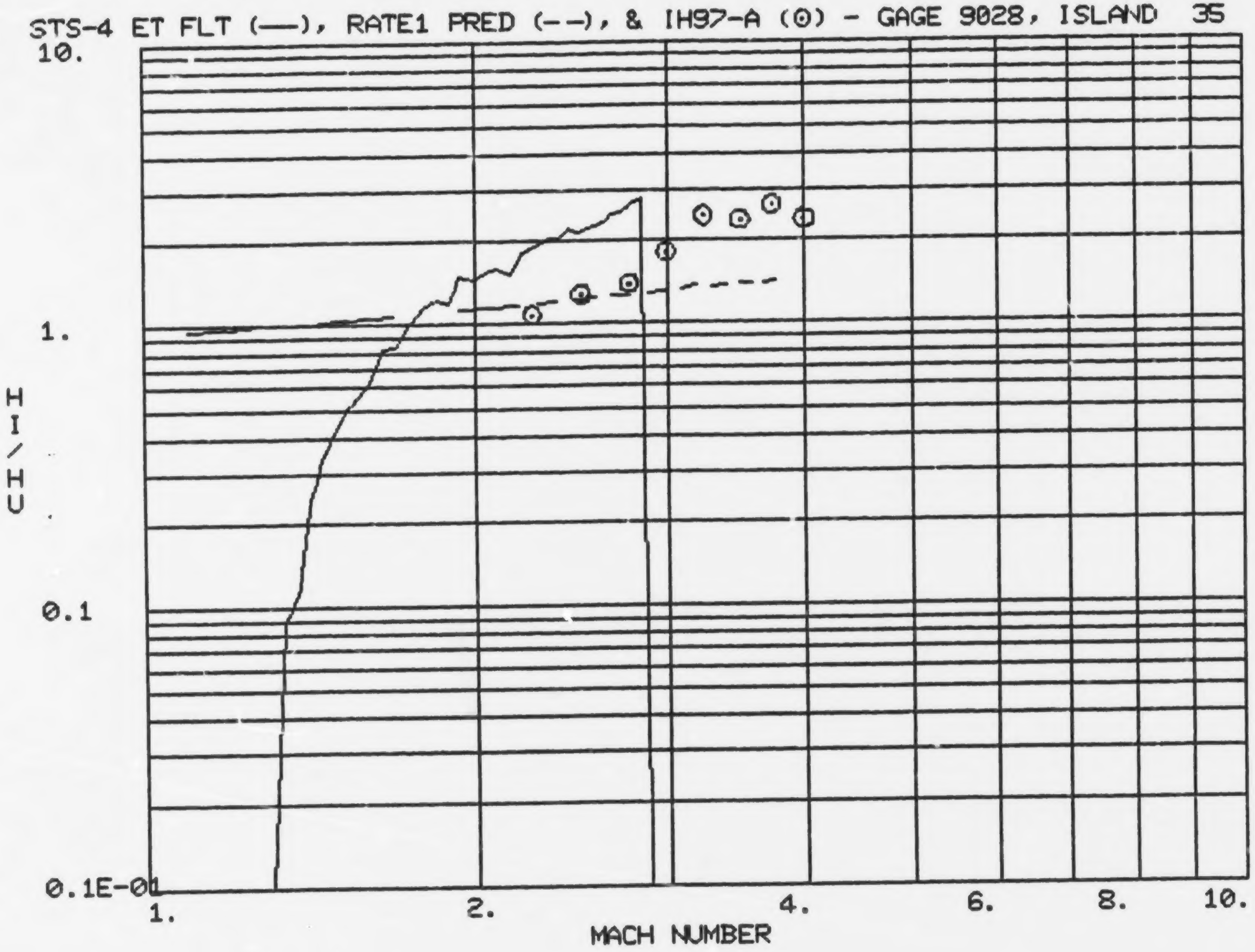

STS-4 ET FLT (—), RATE1 PRED (--), & IH97-A (⊙) - GAGE 9028, ISLAND 35
10.
1.
0.1
0.1E-01
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.23

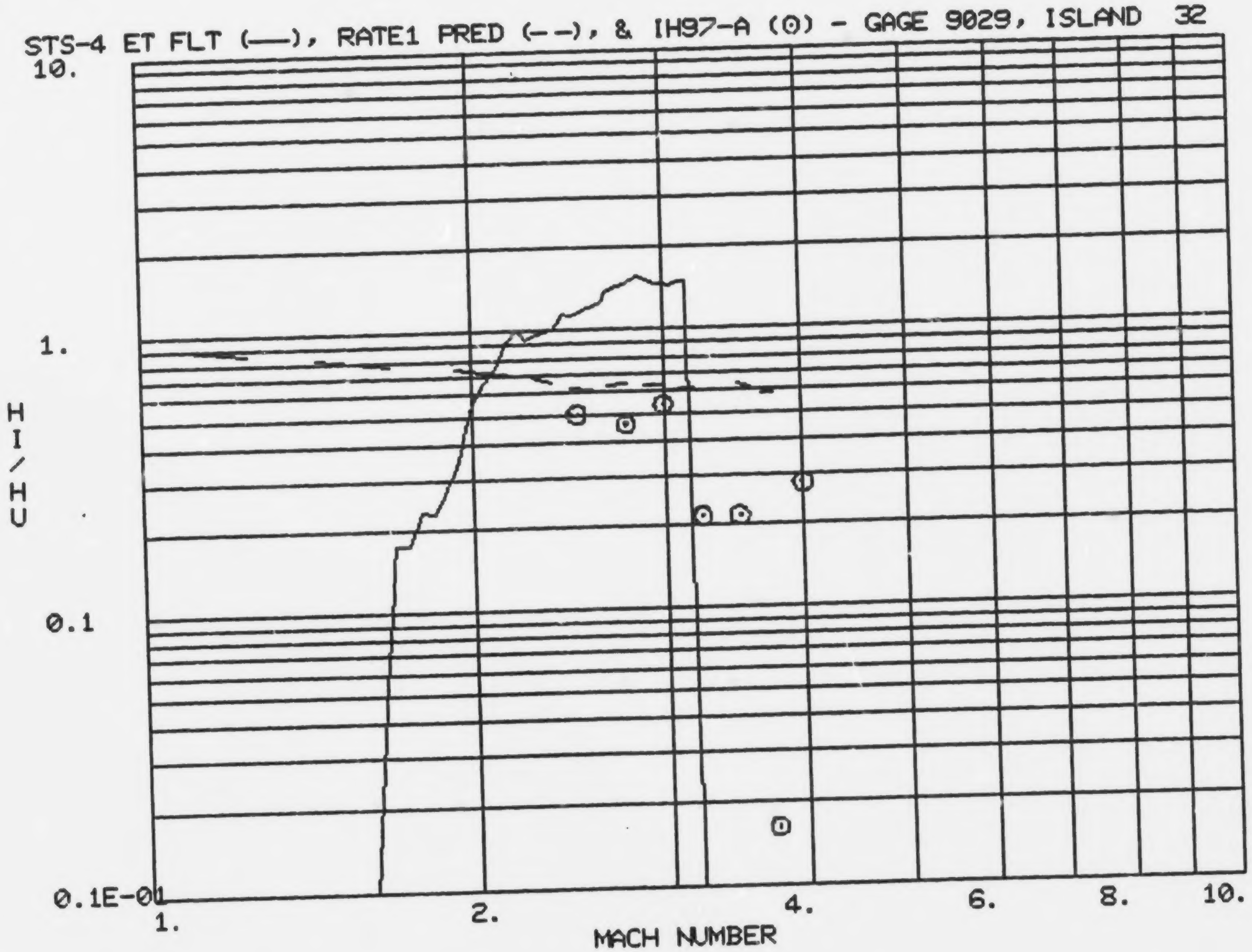
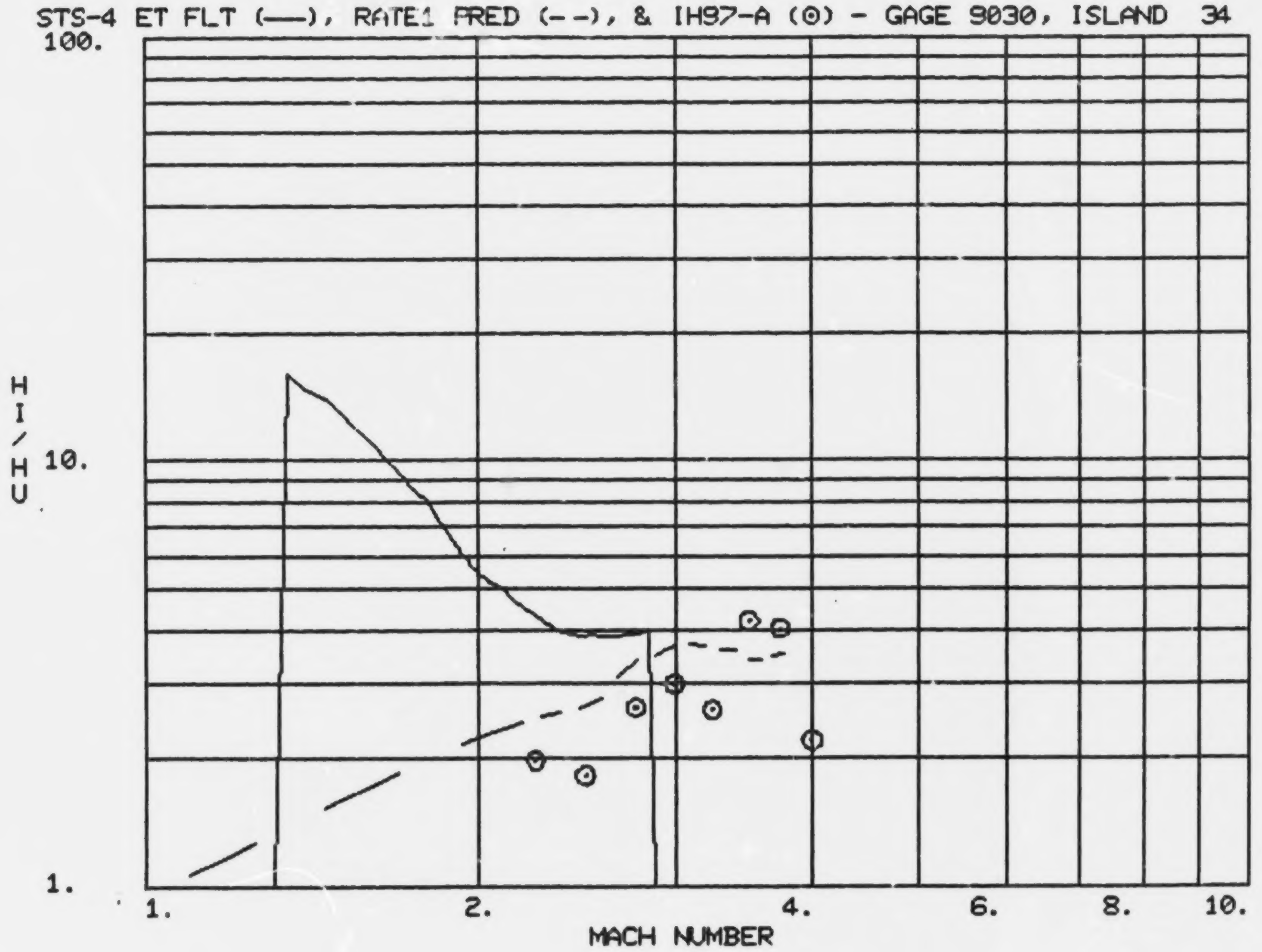

STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9029, ISLAND 32
10.
1.
0.1
0.1E-01
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.24



STS-4 ET FLT (—), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9030, ISLAND 34
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10.
1.
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.25

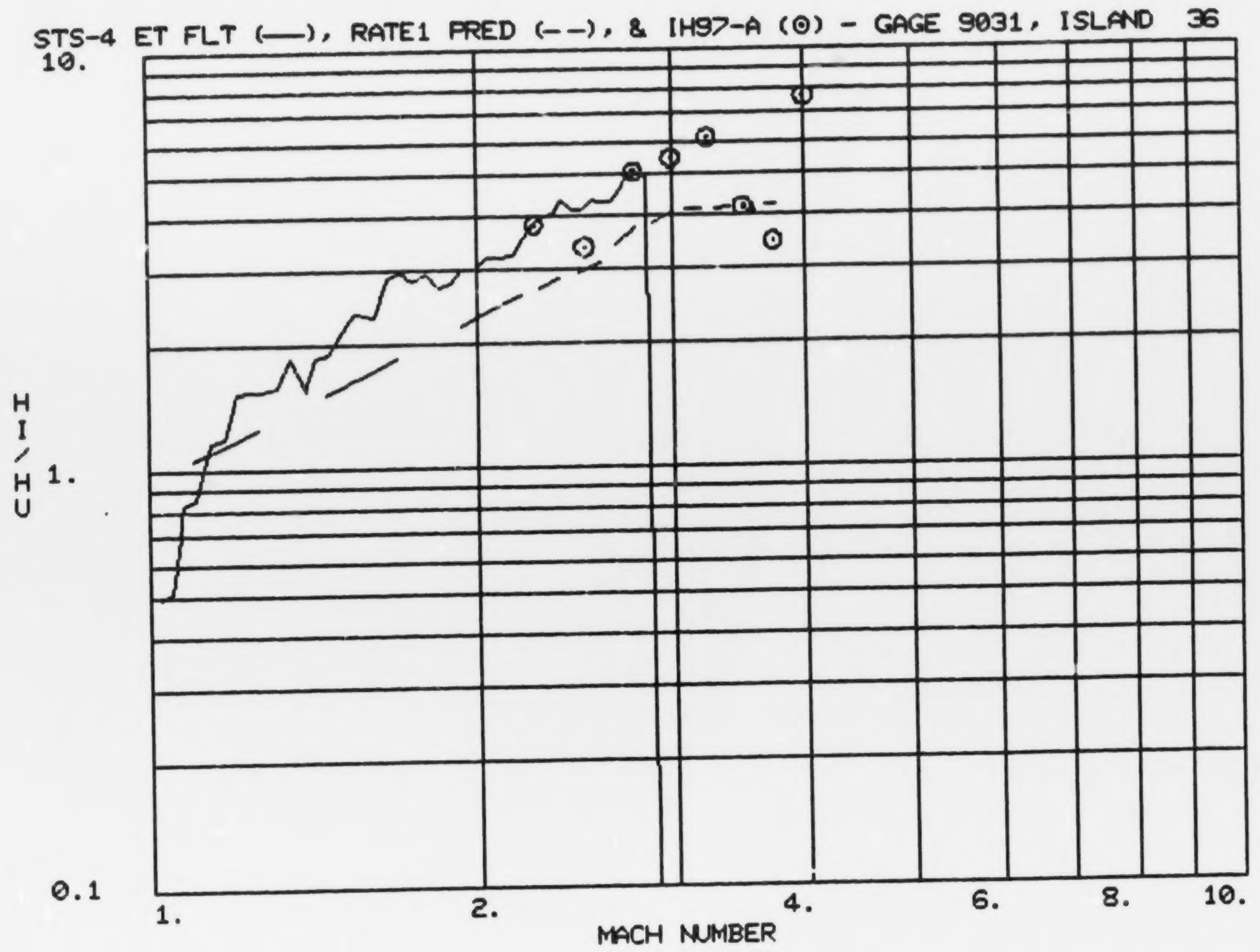

STS-4 ET FLT (—), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9031, ISLAND 36
10.
1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.26

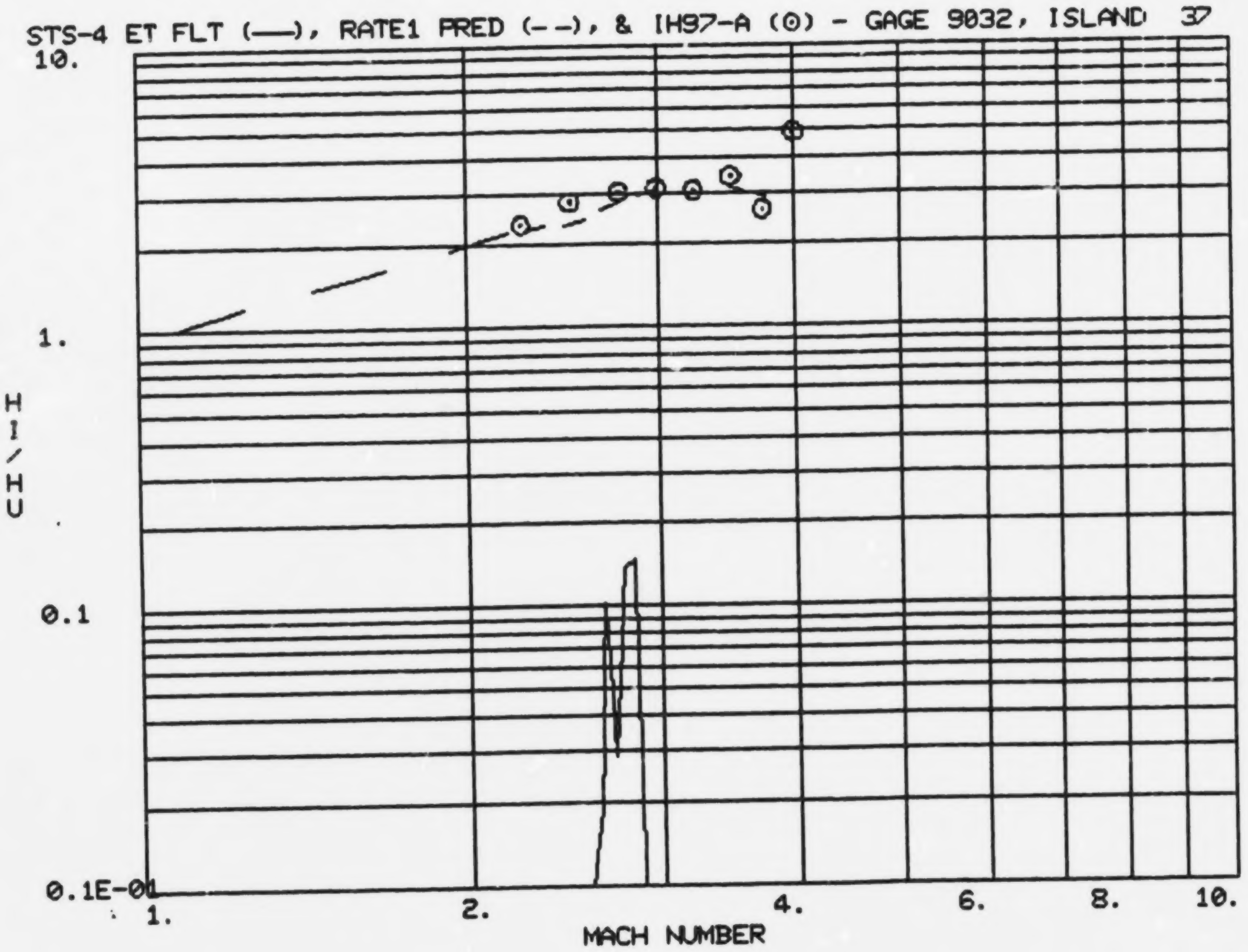
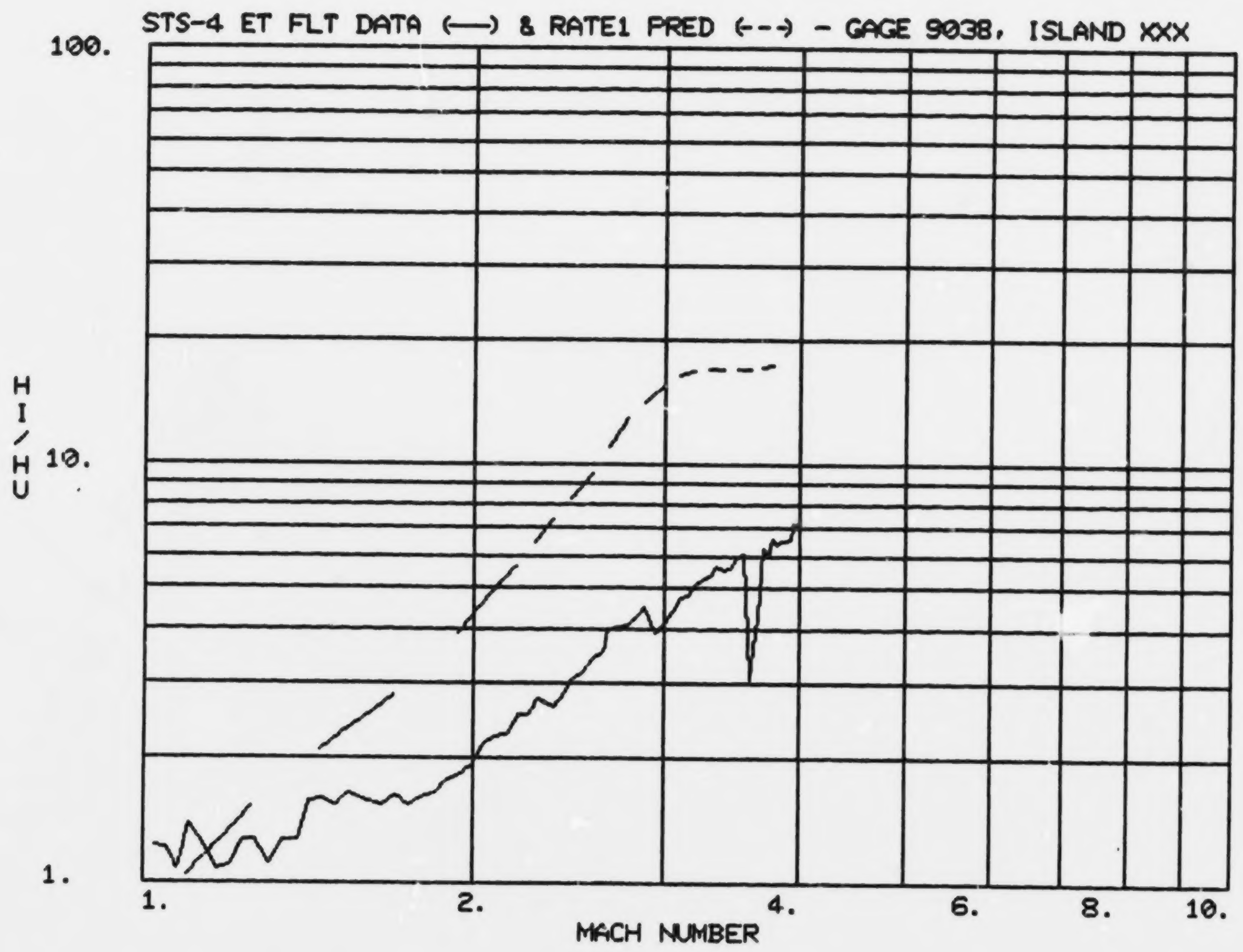

STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9032, ISLAND 37
10.
1.
0.1
0.1E-01
H I / H U
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.27


STS-4 ET FLT DATA (——) & RATE1 PRED (- - -) - GAGE 9038, ISLAND XXX
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10.
1.
H I / H U
1.
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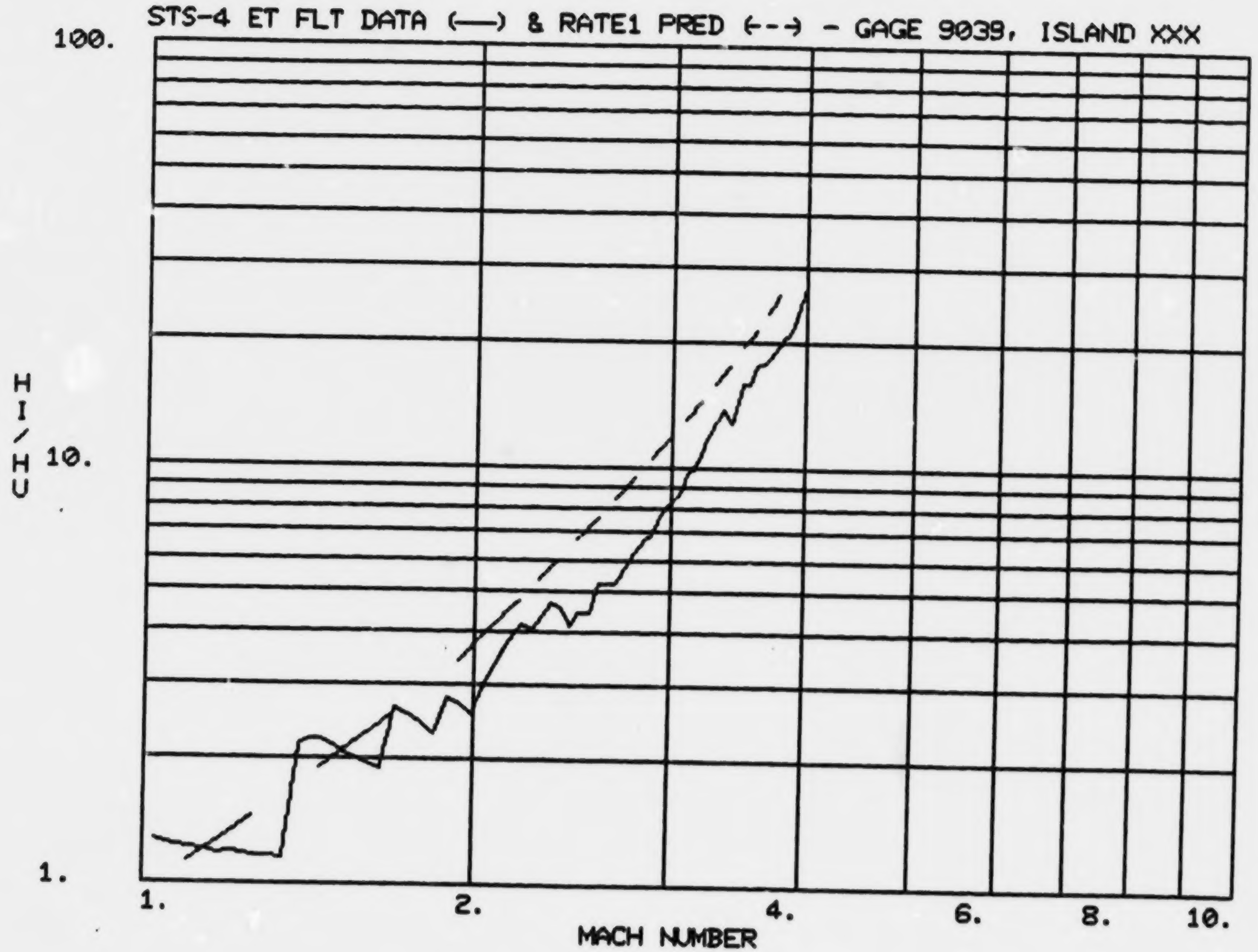
4.
6.
8.
10.
MACH NUMBER

Fig. 4.28


STS-4 ET FLT DATA (—) & RATE1 PRED (- -) - GAGE 9039, ISLAND XXX
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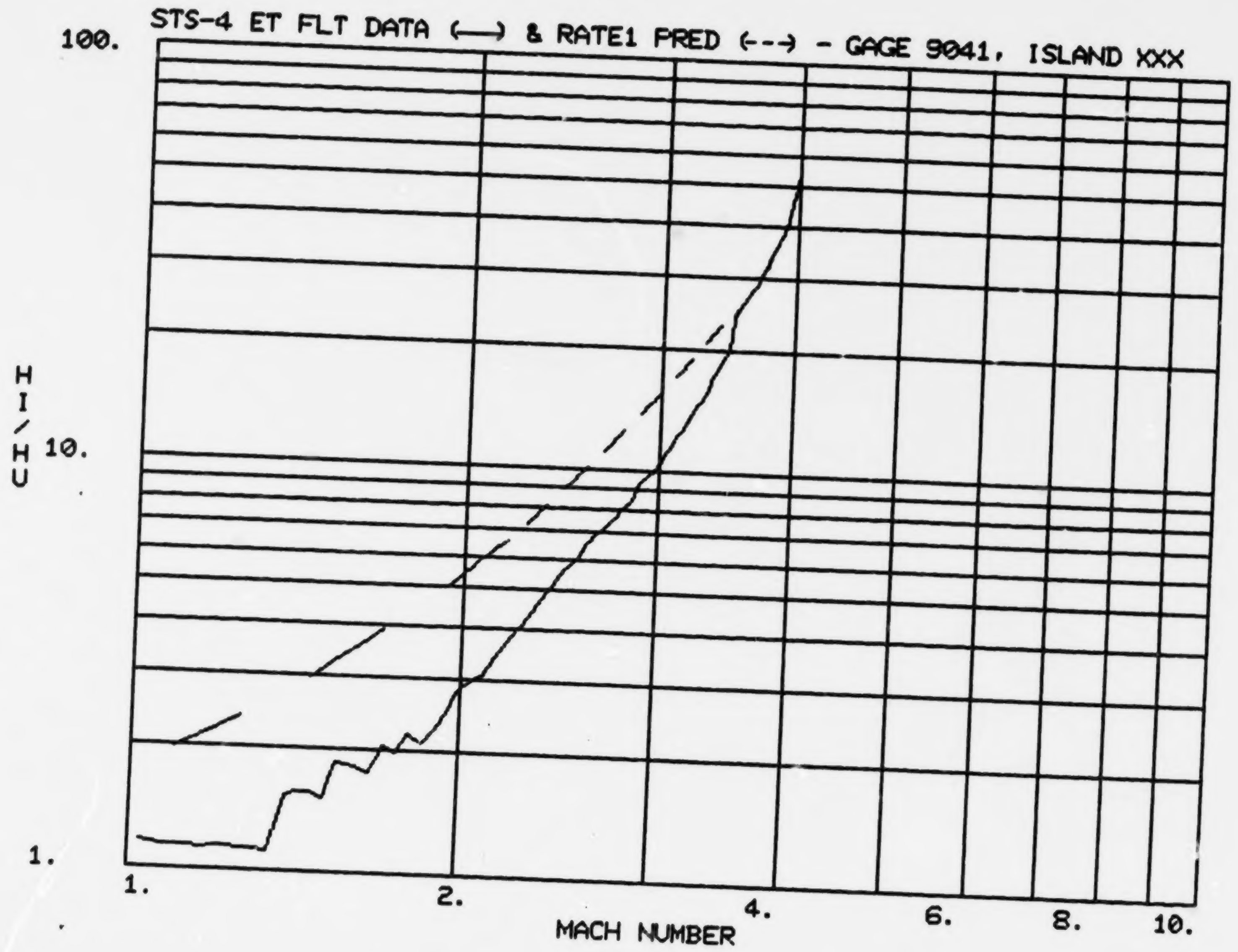
10.
1.
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.29


STS-4 ET FLT DATA (——) & RATE1 PRED (- - -) - GAGE 9041, ISLAND XXX
100.
H
I
/
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10.
1.
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2.
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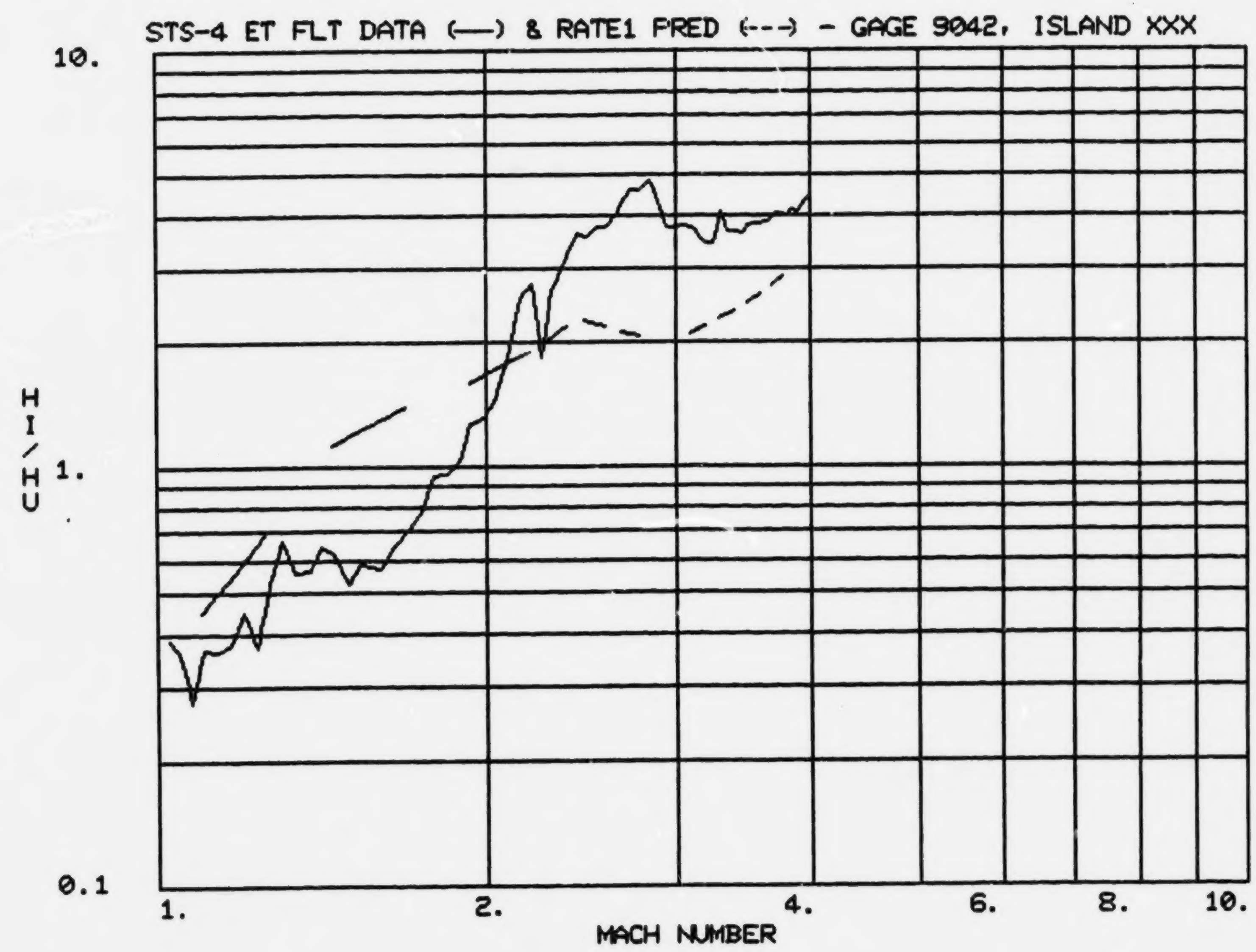
MACH NUMBER

Fig. 4.30


STS-4 ET FLT DATA (—) & RATE1 PRED (---) - GAGE 9042, ISLAND XXX
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0.1
HI/HU
1.
2.
4.
6.
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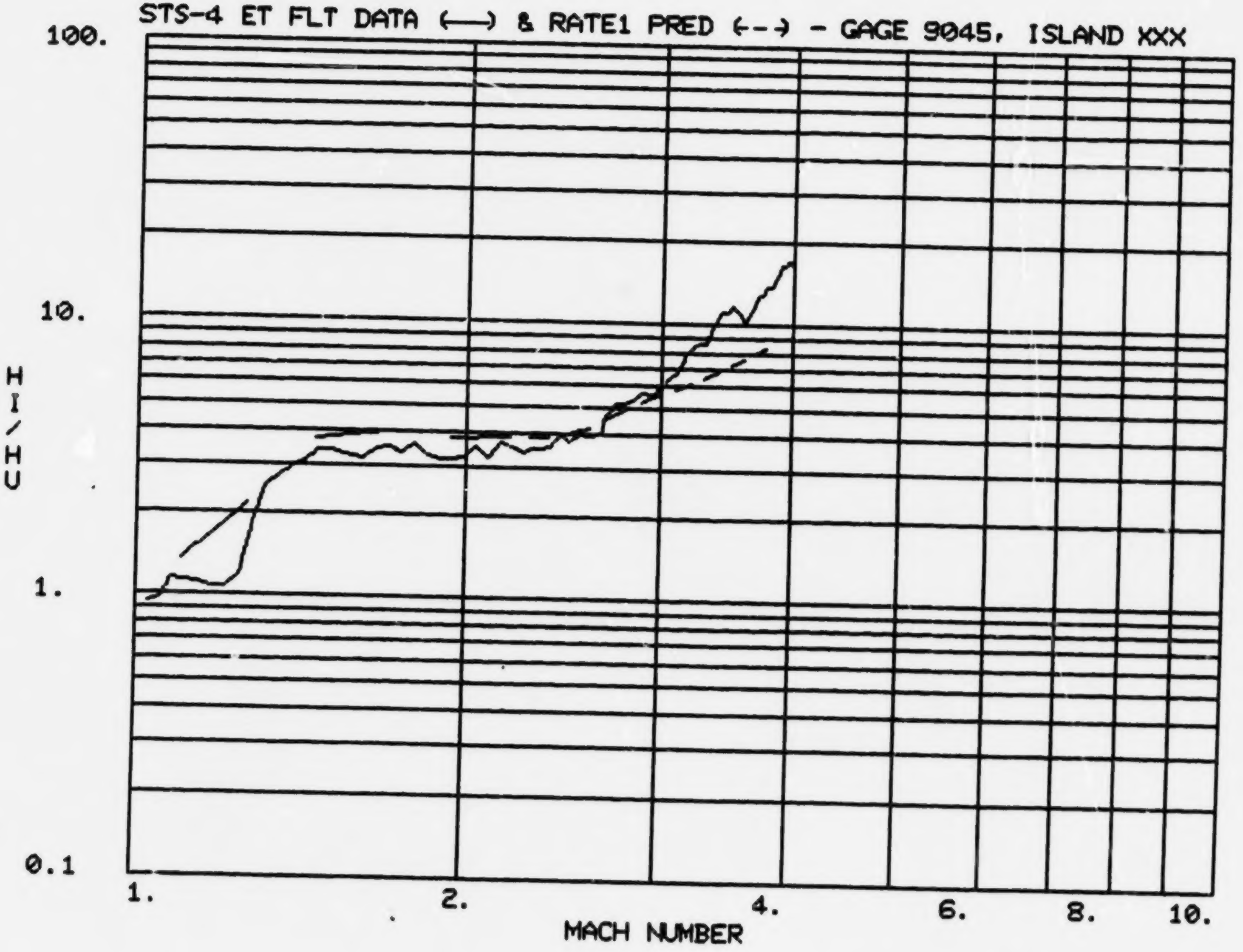
10.
MACH NUMBER

Fig. 4.31



STS-4 ET FLT DATA (——) & RATE1 PRED (- -) - GAGE 9045, ISLAND XXX
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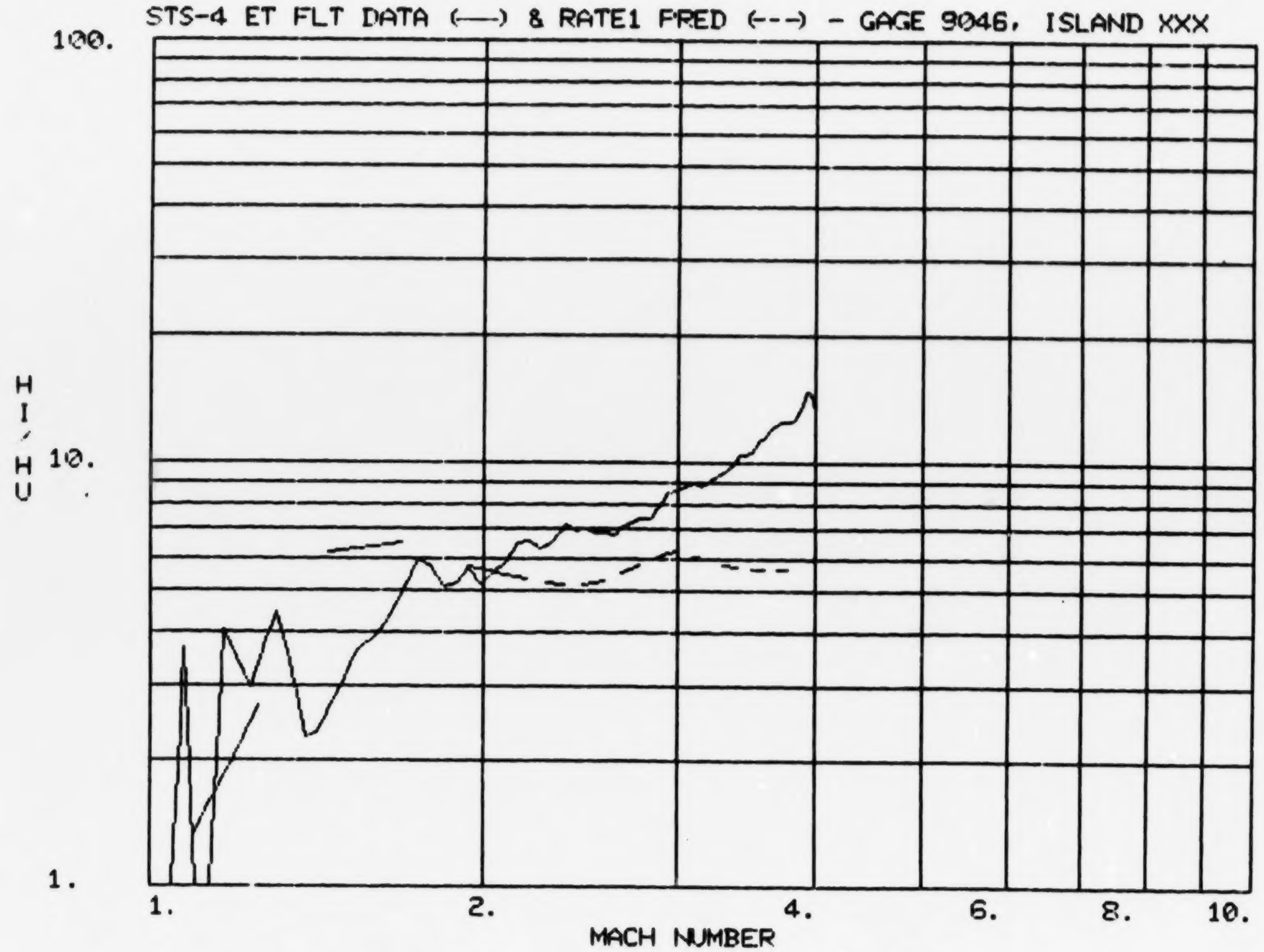
10.
1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.32


STS-4 ET FLT DATA (—) & RATE1 PRED (--) - GAGE 9046, ISLAND XXX
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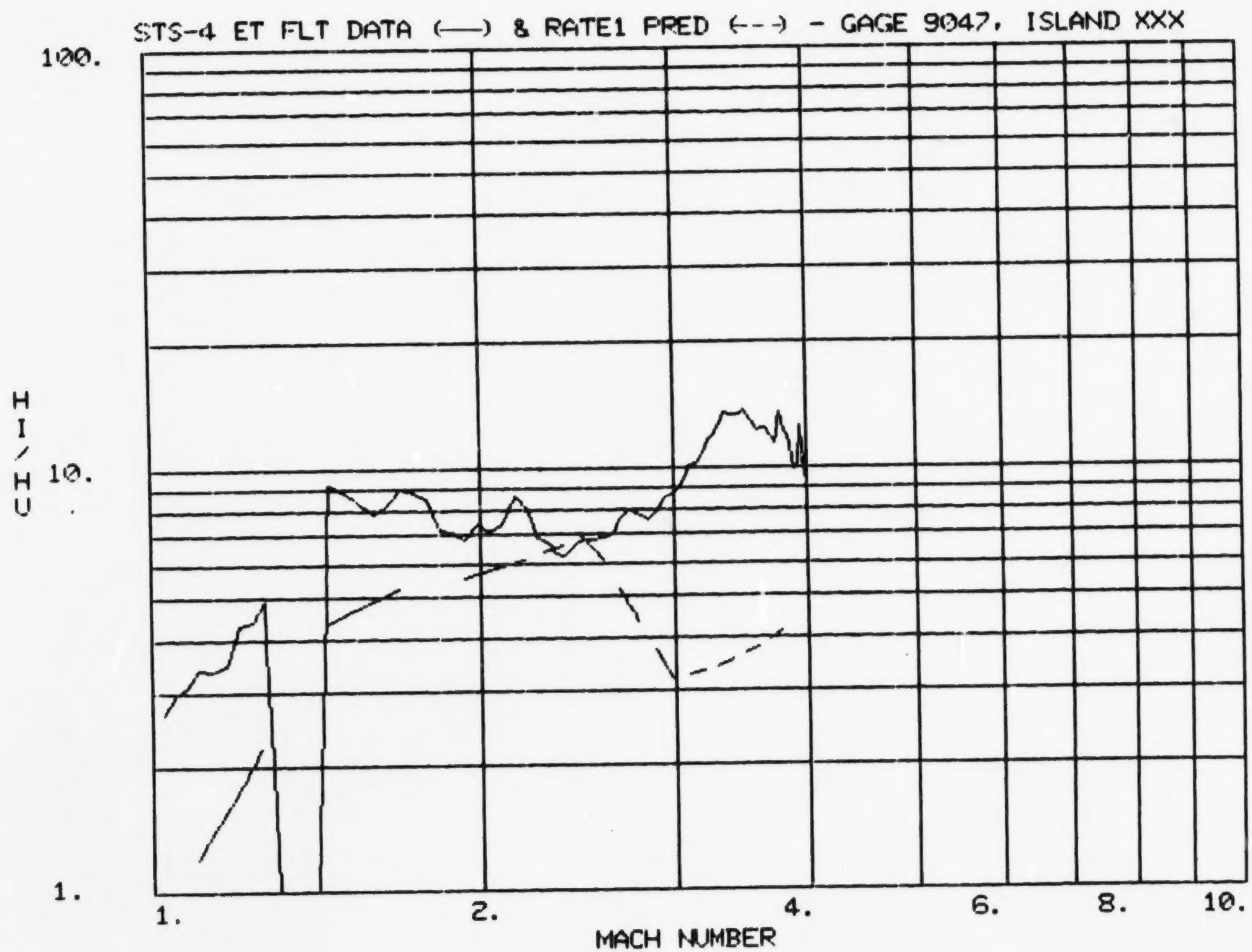
10.
1.
H I / H U
1.
2.
4.
6.
8.
10.
MACH NUMBER

Fig. 4.33


STS-4 ET FLT DATA (——) & RATE1 PRED (- - -) - GAGE 9047, ISLAND XXX
100.
10.
1.
HI/HU
1.
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4.
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8.
10.
MACH NUMBER

Fig. 4.34

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APPENDIX

SET-1

STS-1 pp. 1.1 - 1.10

REMTECH INC.

TECHNICAL NOTE

TITLE:	Comparison of Protuberance DFI Interference Factors Between OFT Flight, Prediction and IH-97A Test Data (From RTN 041-15A)
DATE:	September 26, 1983
AUTHORS:	Dr. Sarat C. Praharaj and Donald R. Hulsey
CONTRACT NO:	NAS8-33373
PREPARED FOR:	George C. Marshall Space Flight Center

DESCRIPTION

This technical note is an addendum to the note, RTN 041-15, which was prepared to compare the OTS turbulent interference factors on acreage DFI locations from flight data prediction and IH-97A test data. The purpose of this note is to present the protuberance DFI interference factor (h_I/h_u) vs. Mach number plots comparing OFT flight data, prediction and IH-97A test data. They are given in the following four sets of plots which are attached as Appendix to this note.

Set 1 - STS-1 pp. 1.1-1.10
Set 2 - STS-2 pp. 2.1-2.10
Set 3 - STS-3 pp. 3.1-3.10
Set 4 - STS-4 pp. 4.1-4.10

Each of the above sets contains tables summarizing the h_I/h_u data from test IH-97A for the protuberance DFI locations. A typical plot compares h_I/h_u data derived from flight measurements, h_I/h_u prediction based on the wind tunnel data base, and h_I/h_u data obtained from test IH-97A. The data reduction procedure

for the flight data is documented elsewhere (Ref. 1). The prediction procedure, which is common to all flights, is described in detail for STS-1 in Ref. 2. As far as the ET protuberance DFI data in test IH-97A, the tabulated data are reported in Ref. 3. It should be noted here that the h_u values in the h_l/h_u data for all the above plots are based on the flat-plate values calculated on the ET skin. It should further be noted that this flat-plate h_u value can easily be changed to an undisturbed value corresponding to a protuberance by a multiplier while considering the turbulent regime.

REFERENCES

1. Praharaj, S. C. and Engel, C. D., "STS Orbital Flight Test (OFT) External Tank Aerothermal Flight Evaluation," REMTECH, Inc., Huntsville, Alabama, Technical Report (Under Preparation).

2. Praharaj, S. C. and Engel, C. D., "STS-1 ET Aerothermal Flight Evaluation," REMTECH, Inc., Huntsville, Alabama, Technical Report 041-1, April 1982.

3. Somers, R. E. and Warmbrod, J. D., "External Tank Protuberance Heat Transfer Data Tables For Test IH-97A," REMTECH, Inc., Huntsville, Alabama, Report RM 032-10, August 1983.

APPENDIX

SET-1

STS-1 pp. 1.1 - 1.10

Table 1.1 STS-1 PROTUBERANCE DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln. Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2054.0*	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2030.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

*X_T Distance corrected on September 23, 1983. The new value has no impact on any previous analysis.

TABLE 1.2 STS-1 ET INTERFERENCE FACTORS FOR PROTUBERANCE POINTS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9012	5053	1.135	1.163	1.204	1.225	1.359	1.313	1.190
9038	5054	1.761	2.001	1.847	1.868	1.728	1.716	2.408
9039	5057	—	—	—	—	—	—	—
9040	5055	1.585	1.527	1.945	2.079	2.041	2.105	1.975
9041	5058	10.682	—	14.052	16.421	14.304	19.406	21.470
9042	5059	6.192	—	—	—	—	—	—
9043	5056	2.254	—	—	—	—	—	—
9045	5060	2.546	2.750	2.888	2.915	2.757	2.280	2.217
9046	5061	8.668	8.294	8.068	5.334	4.024	3.294	2.295
9047	5062	2.998	3.420	3.424	3.824	5.989	—	—

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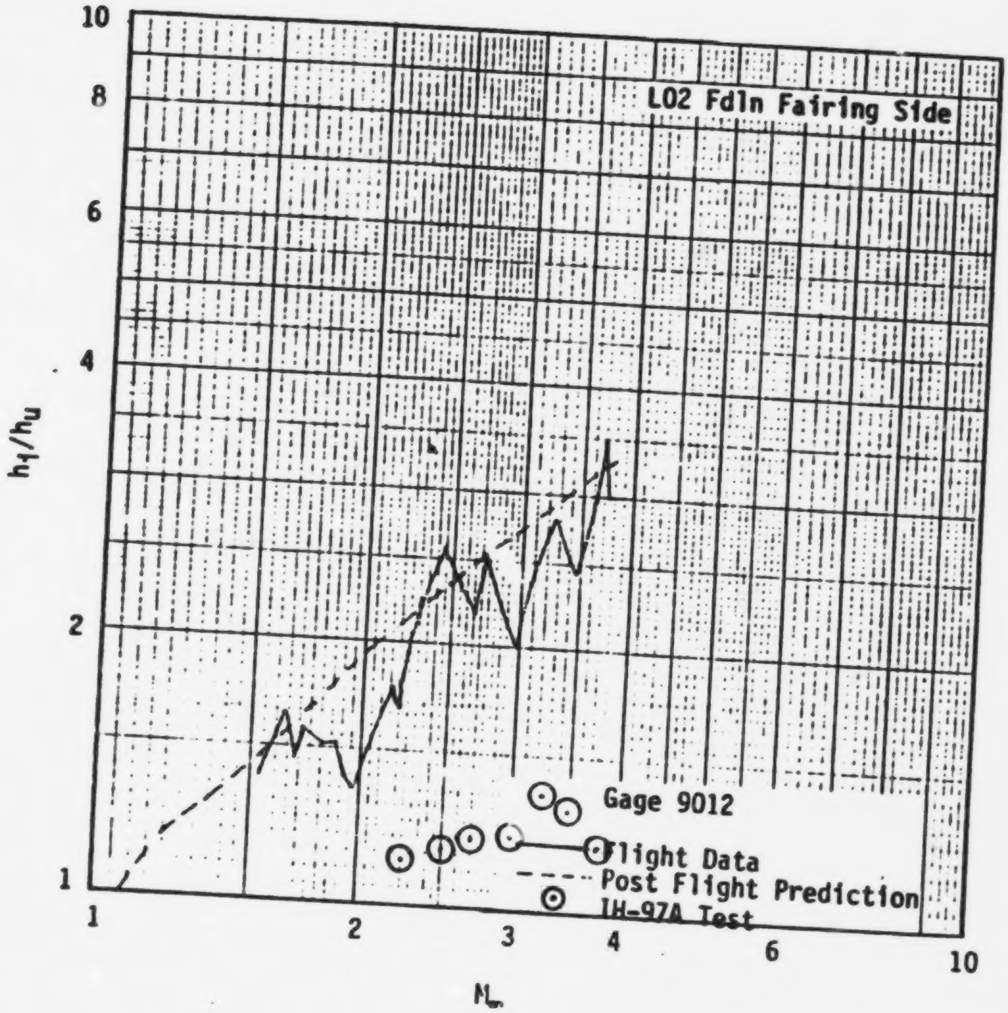

STS-1 Post Flight Interference Factors for Gage 9012

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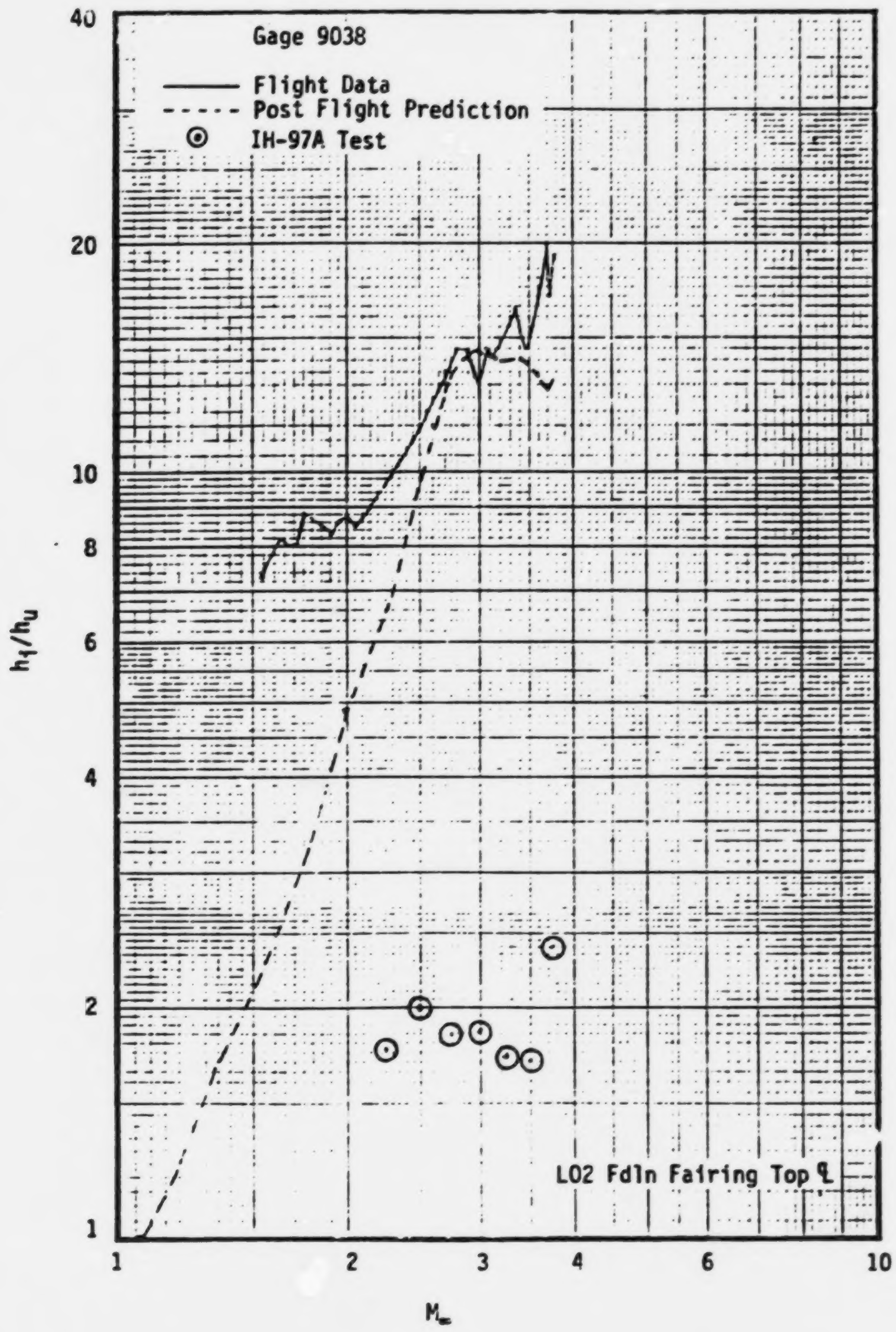

STS-1 Post Flight Interference Factors for Gage 9038

REMTECH INC.

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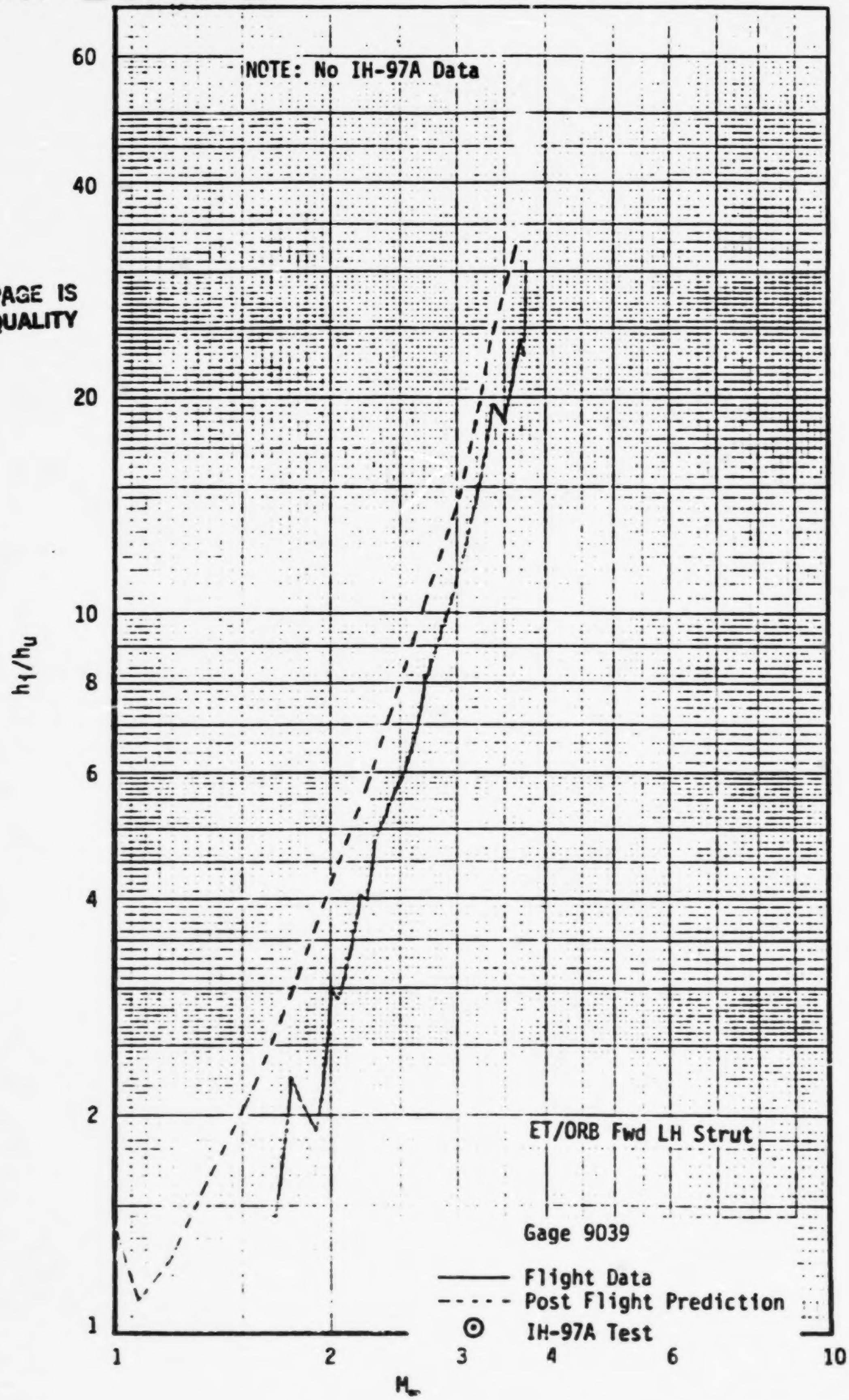

STS-1 Post Flight Interference Factors for Gage 9039

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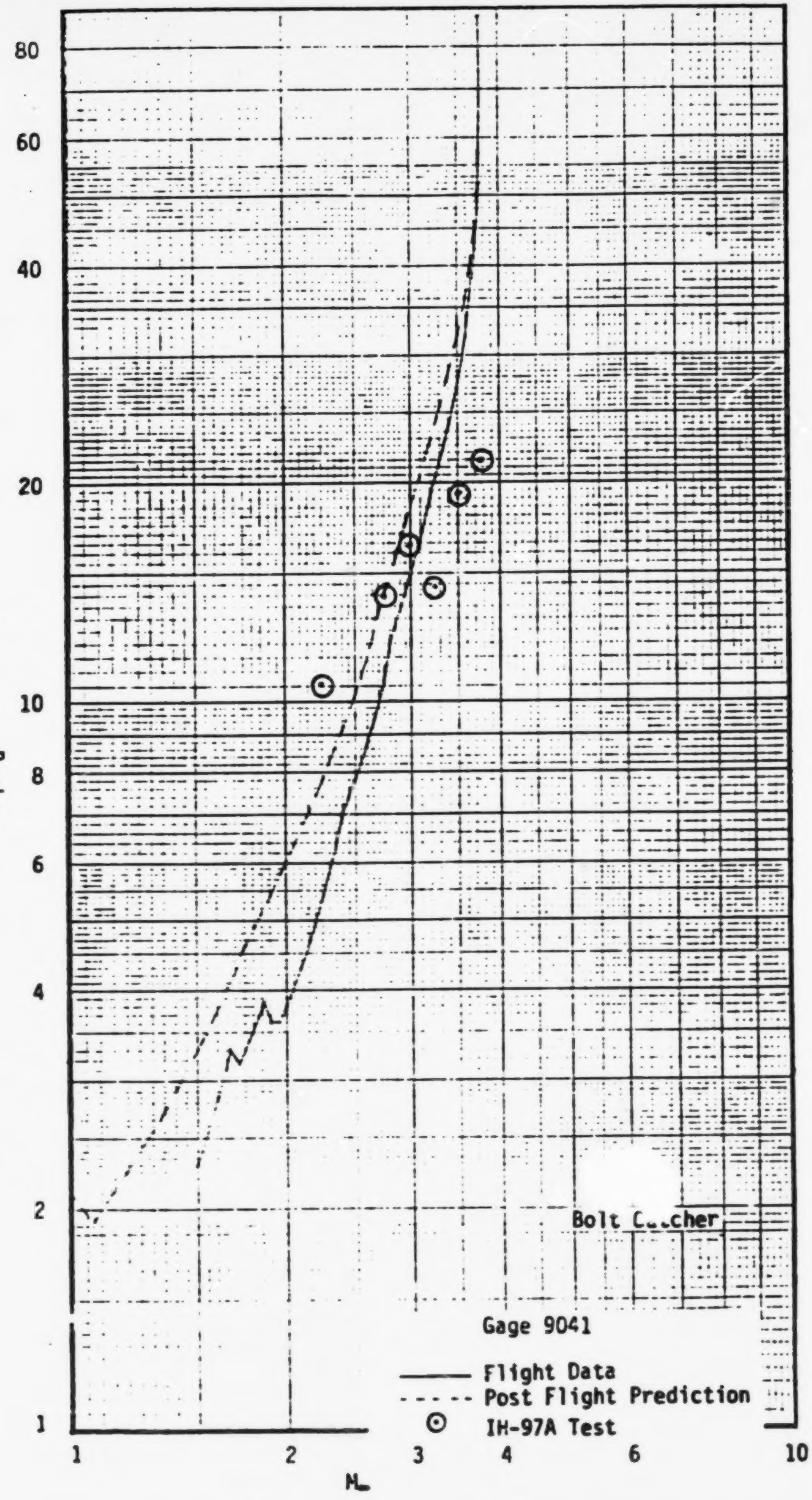

STS-1 Post Flight Interference Factors for Gage 9041

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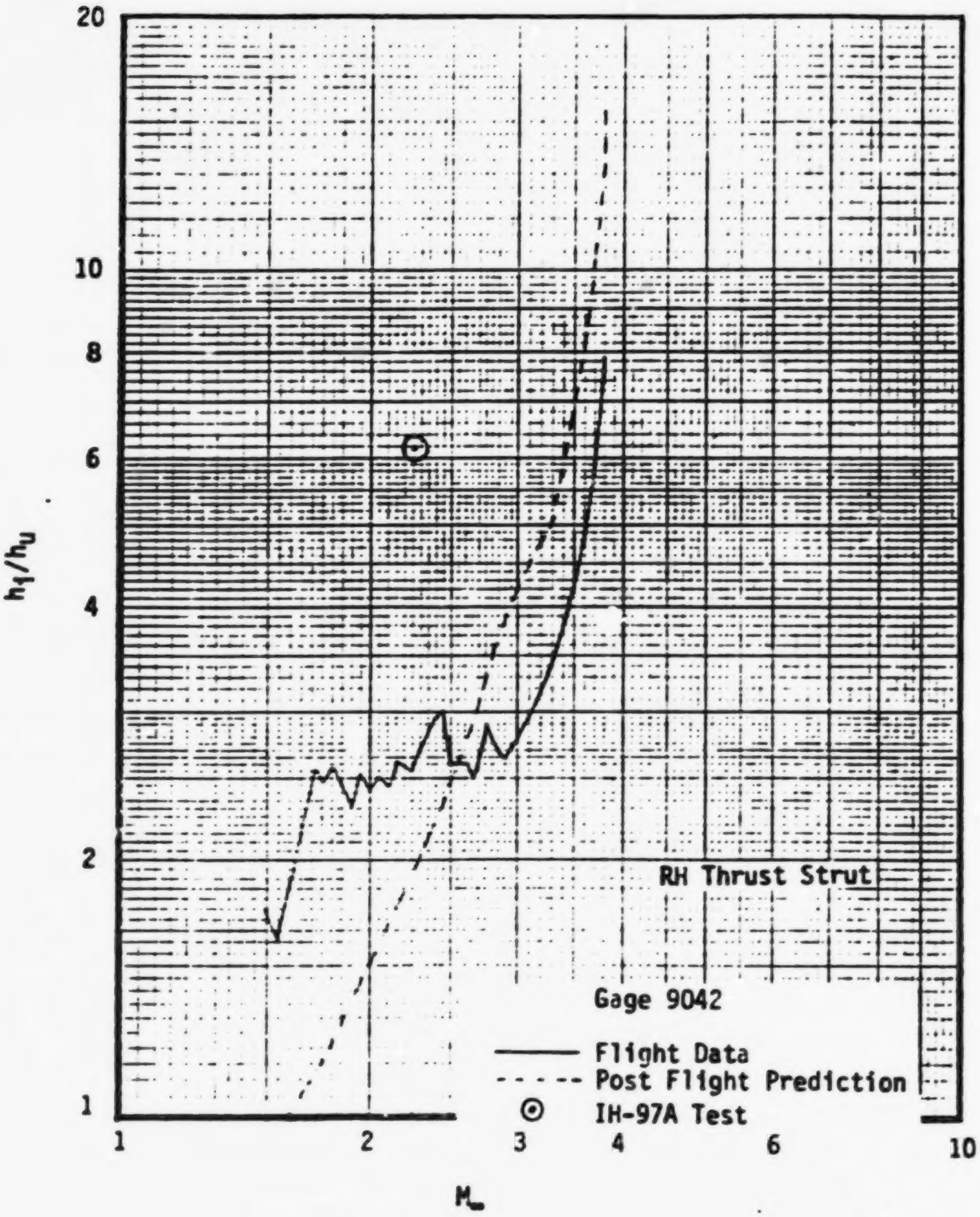

STS-1 Post Flight Interference Factors for Gage 9042

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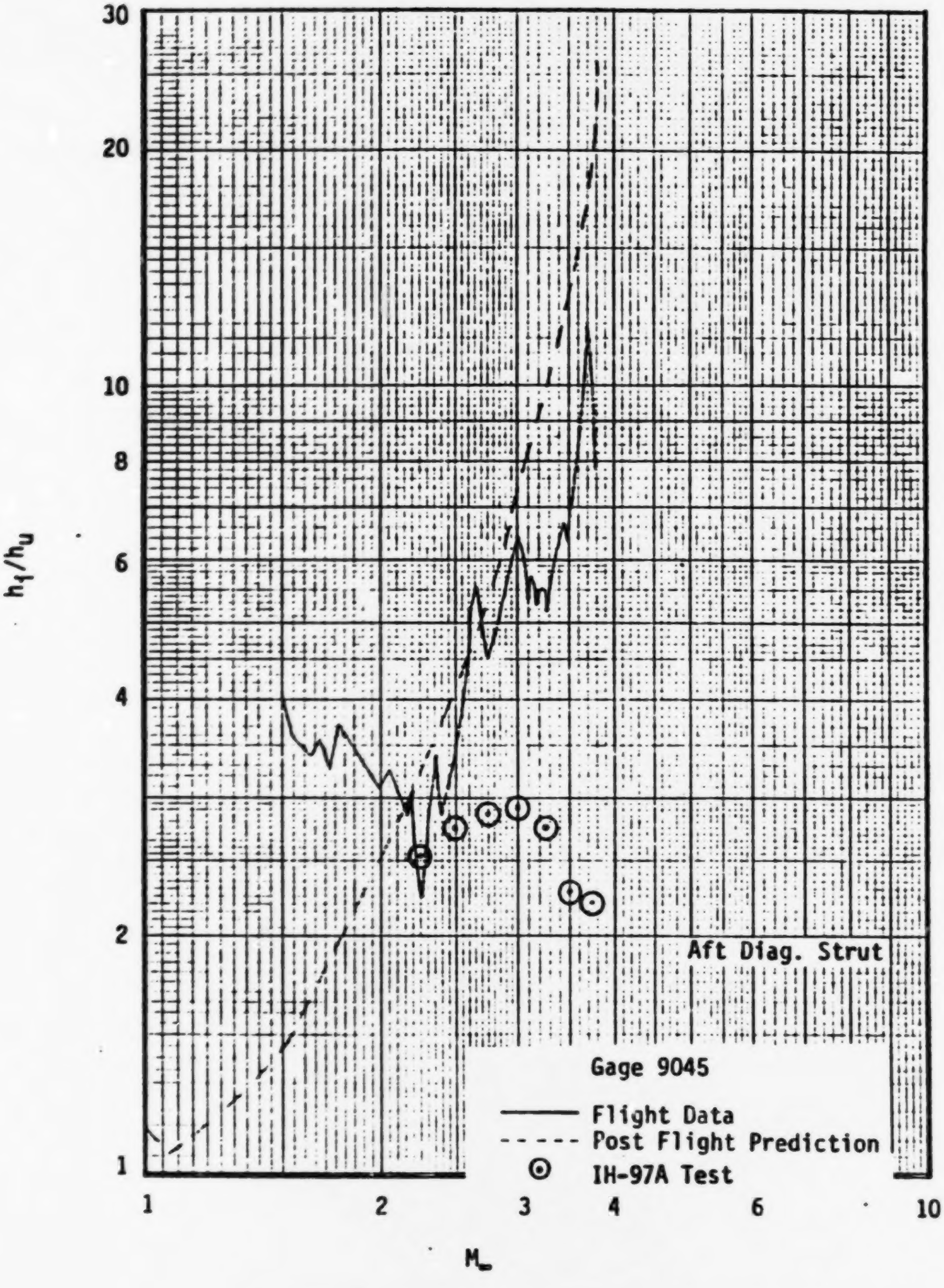
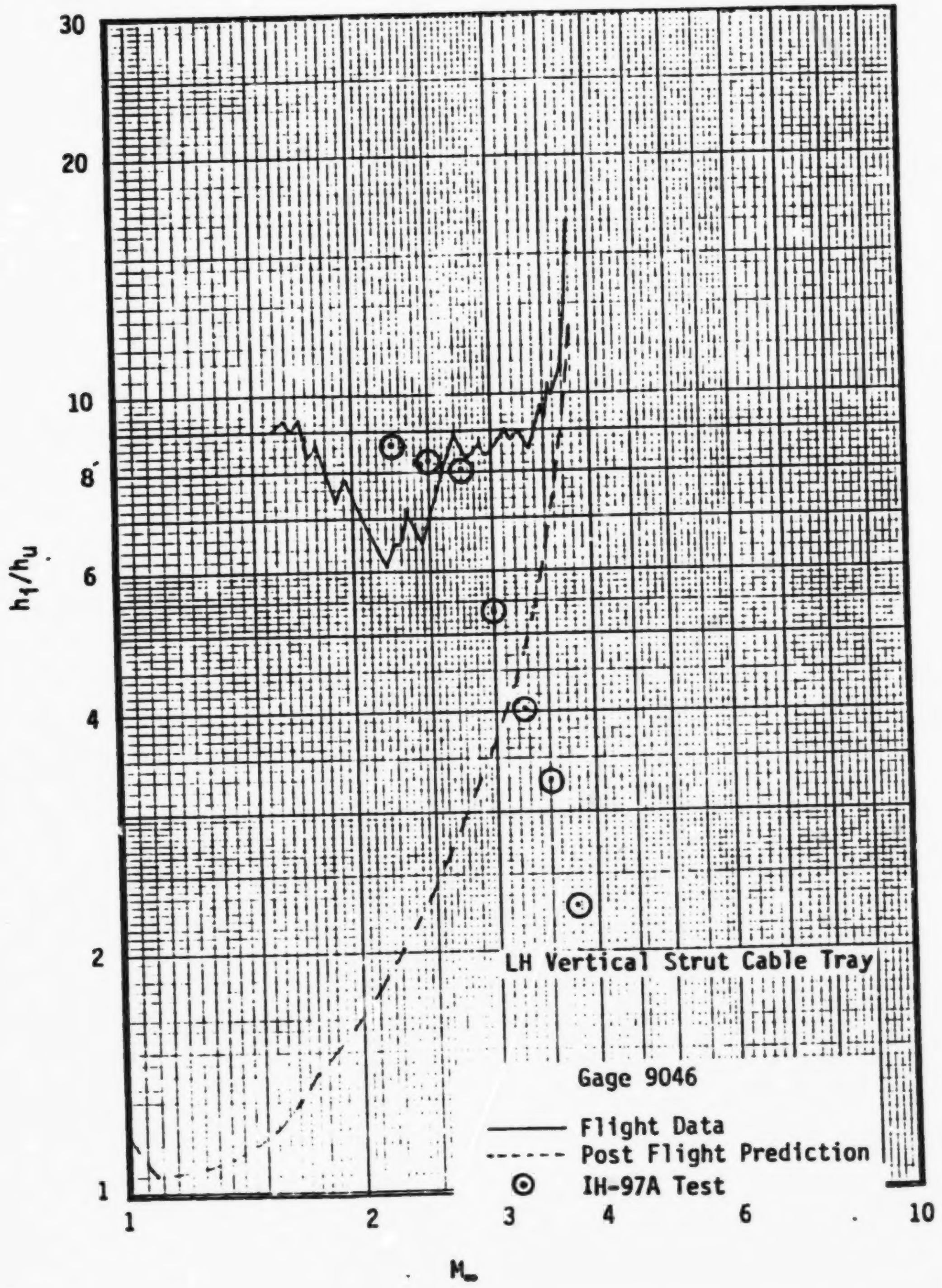


STS-1 Post Flight Interference Factors for Gage 9045



STS-1 Post Flight Interference Factors for Gage 9046

REMTECH INC.

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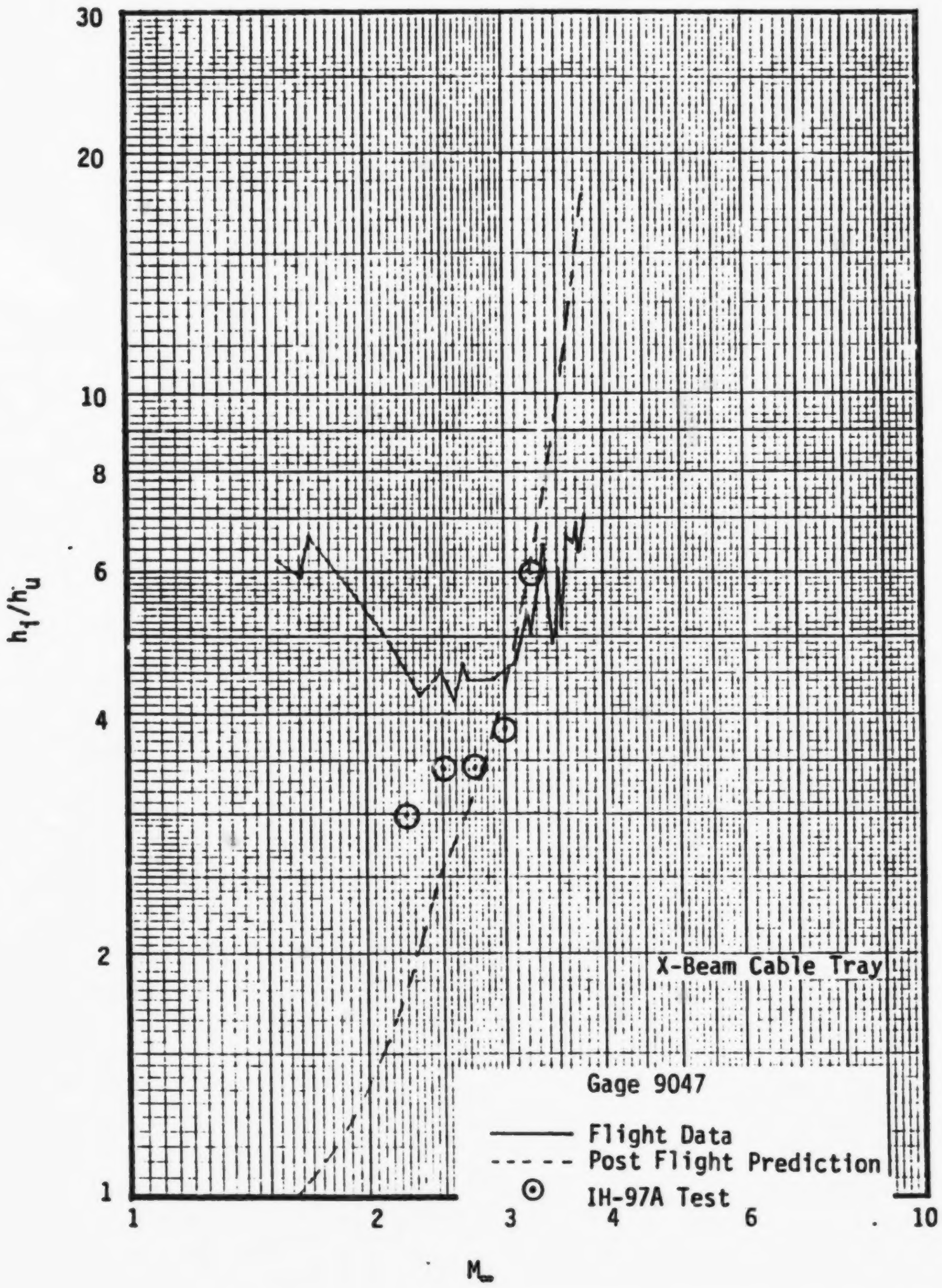


STS-1 Post Flight Interference Factors for Gage 9047

REMTECH INC.

SET-2

STS-2 pp. 2.1 - 2.10

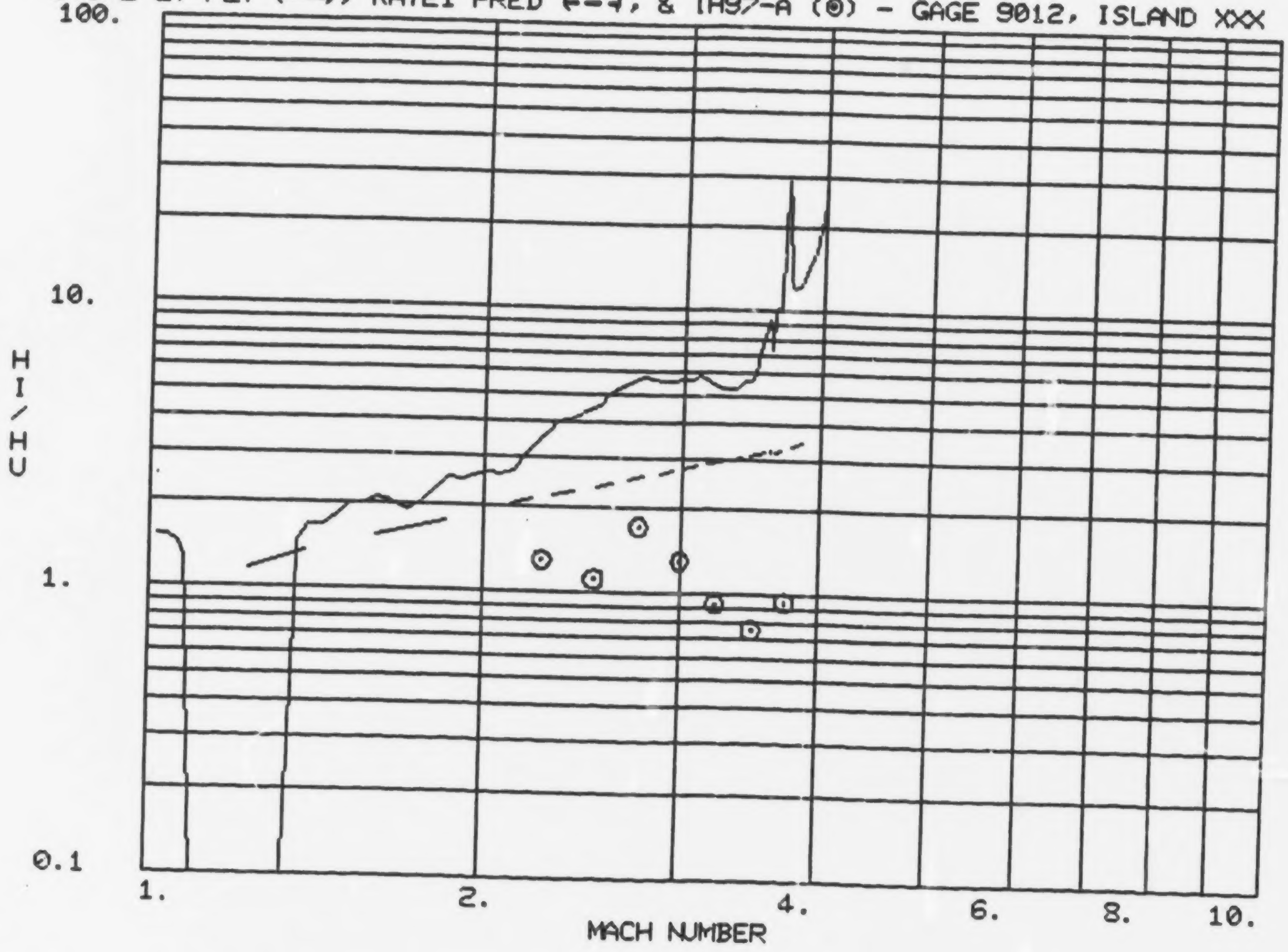
Table 2.1 STS-2 PROTUBERANCE DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln. Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2054.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2030.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

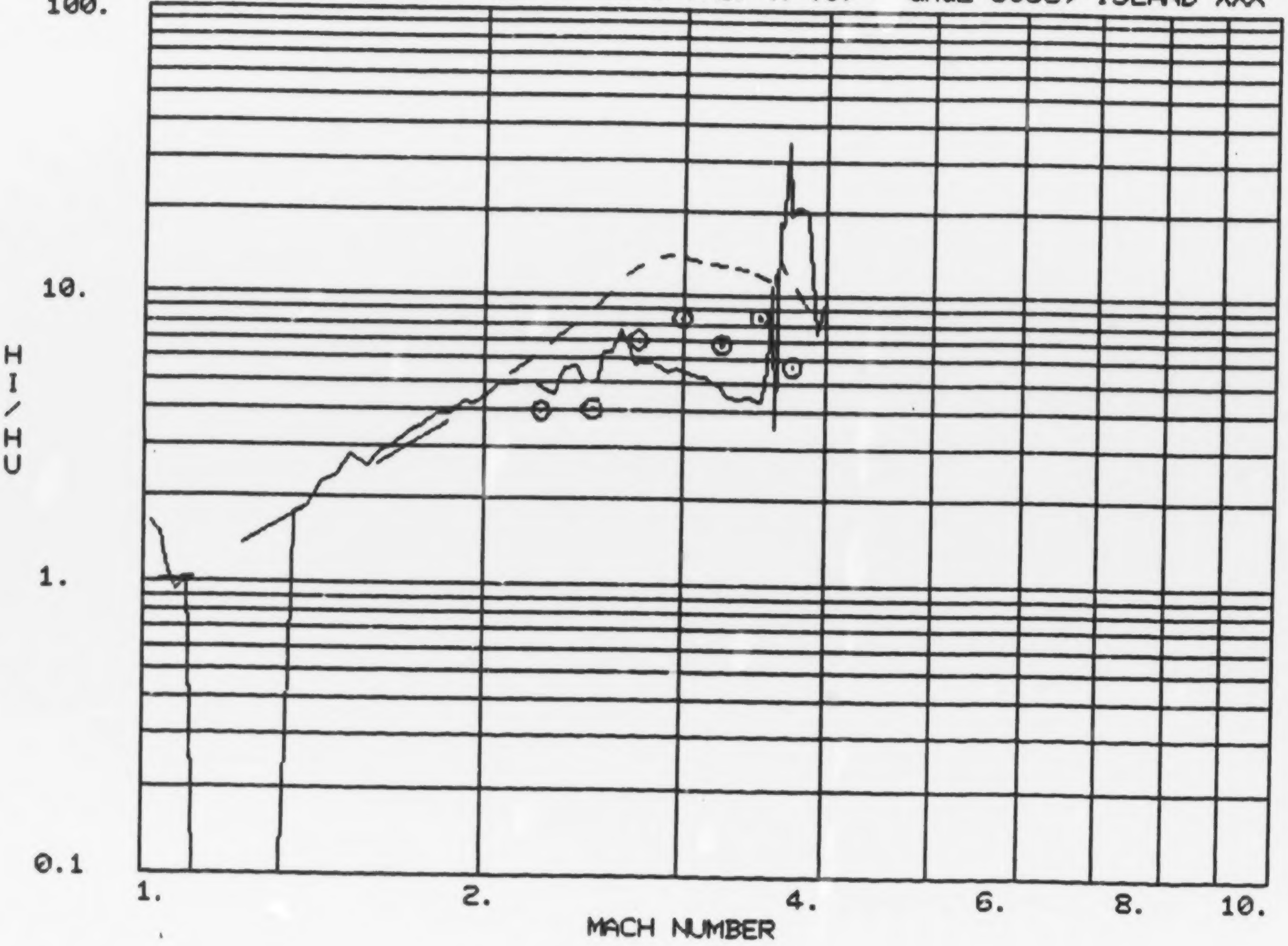
TABLE 2.2 STS-2 ET INTERFERENCE FACTORS FOR PROTUBERANCE POINTS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9012	5053	1.295	1.116	1.697	1.301	0.930	0.759	0.950
9038	5054	3.937	4.002	6.988	8.358	6.781	8.468	5.702
9039	5057	—	—	—	—	—	—	—
9040	5055	1.815	1.477	1.666	1.769	1.438	1.183	1.934
9041	5058	10.123	12.633	14.742	18.618	17.613	22.212	25.560
9042	5059	—	—	—	—	—	—	—
9043	5056	1.322	—	—	—	—	—	—
9045	5060	2.981	3.507	4.001	3.826	3.504	3.191	2.937
9046	5061	5.340	5.721	4.376	3.973	2.773	3.164	2.332
9047	5062	5.311	5.907	7.103	7.065	7.911	—	—

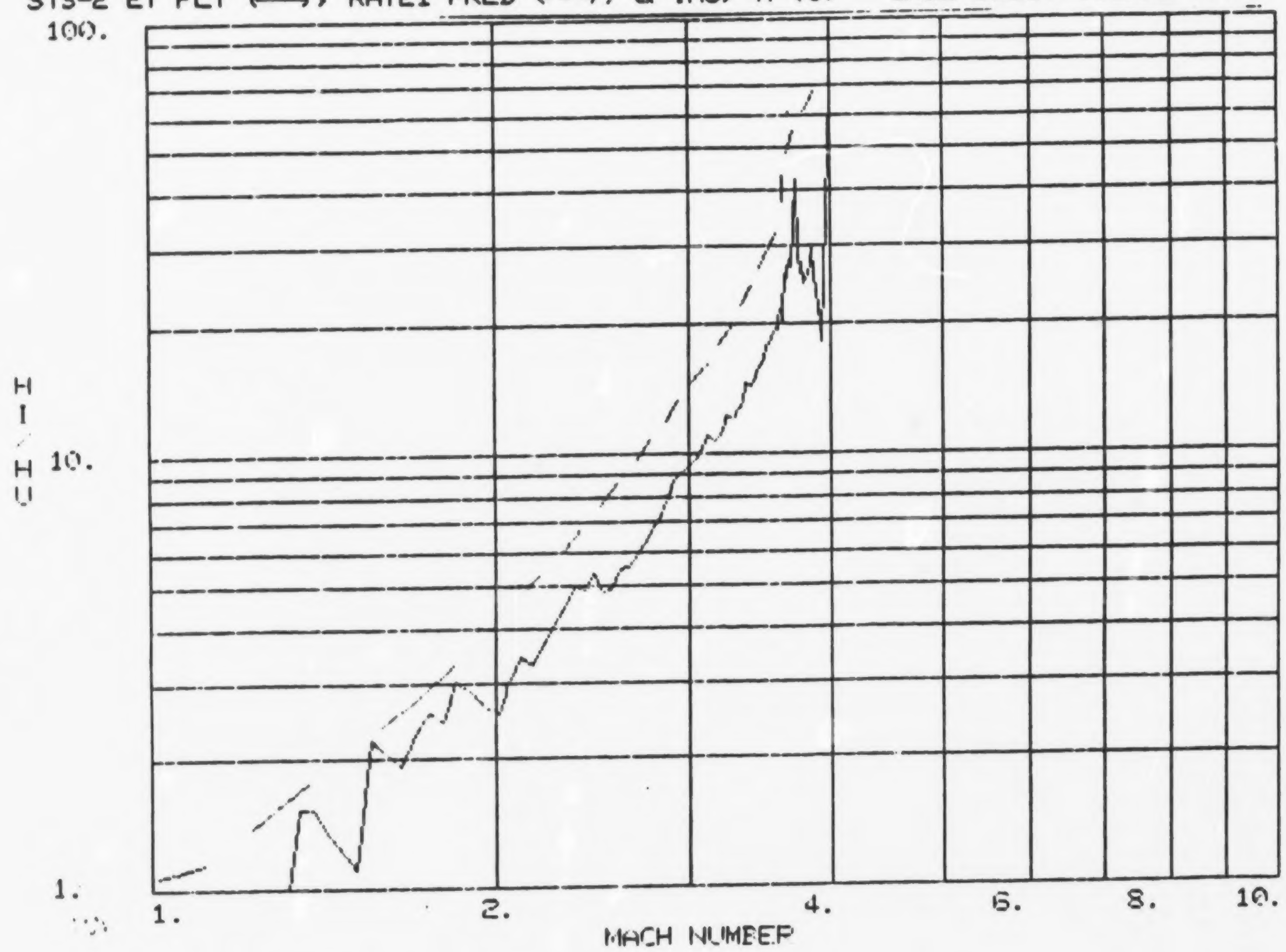
STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9012, ISLAND XXX



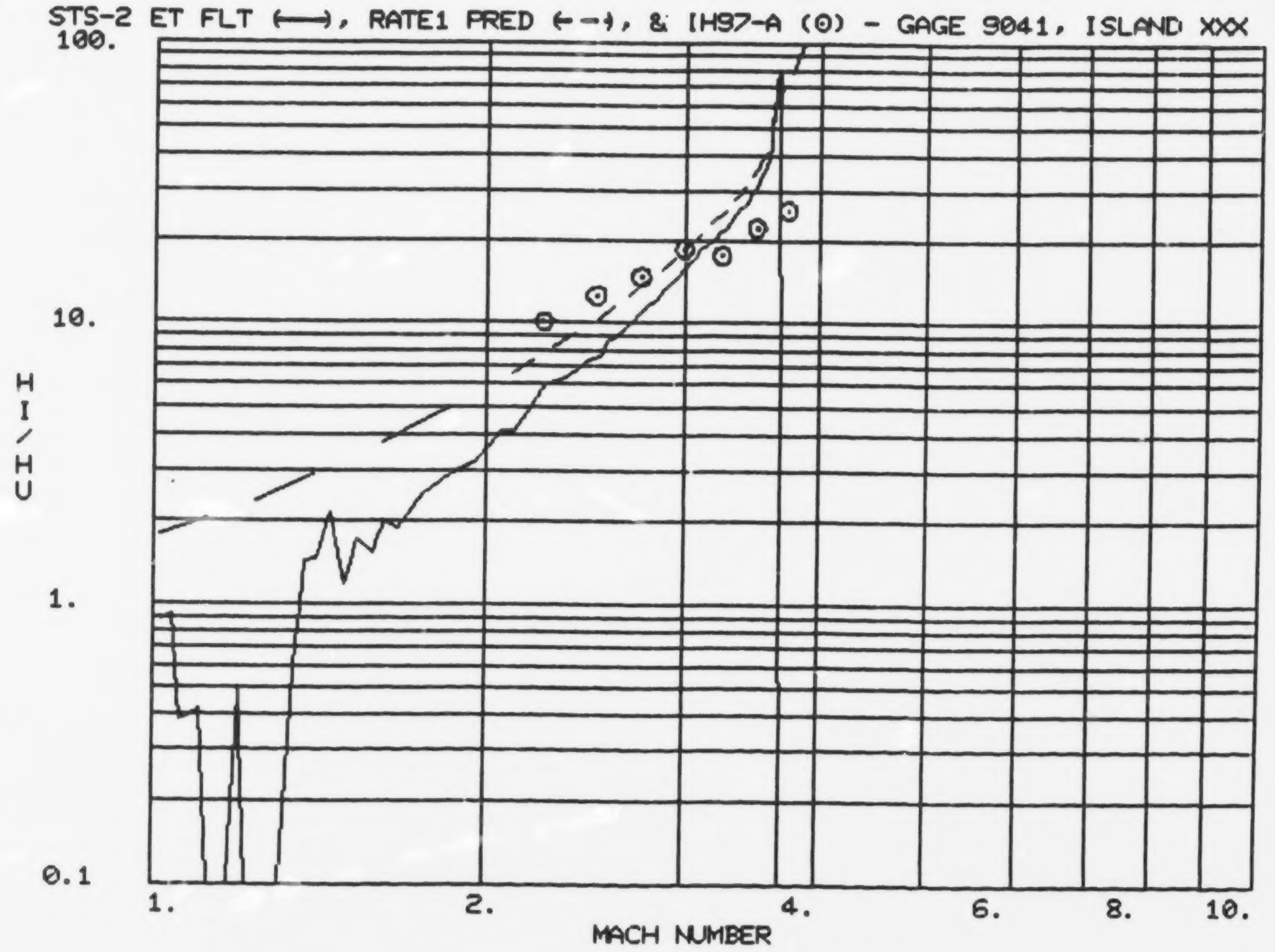
STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (O) - GAGE 9038, ISLAND XXX



STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (◎) - GAGE 9039, ISLAND XXX



NOTE: No IH-97A Data



STS-2 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9041, ISLAND XXX
100.
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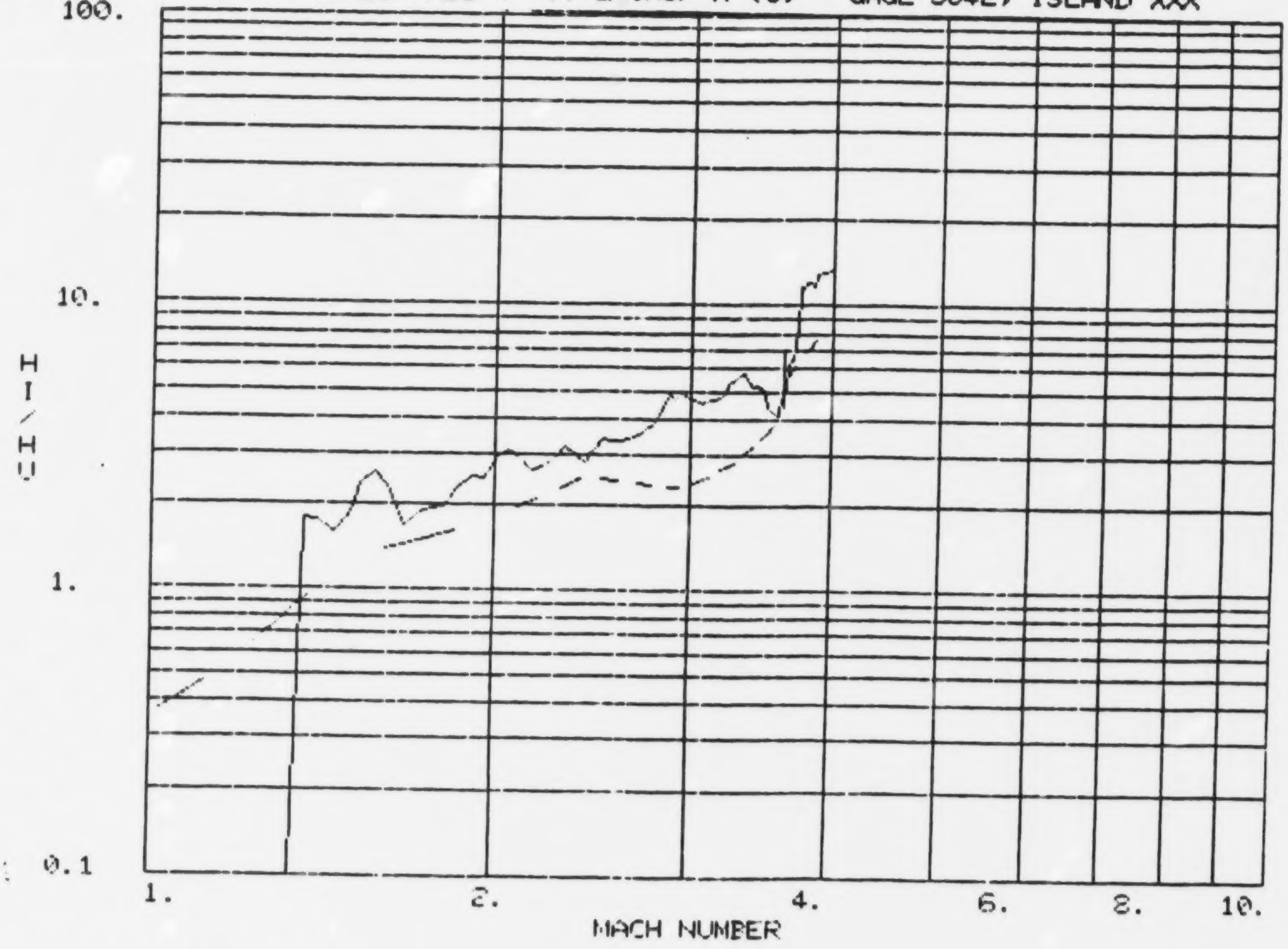
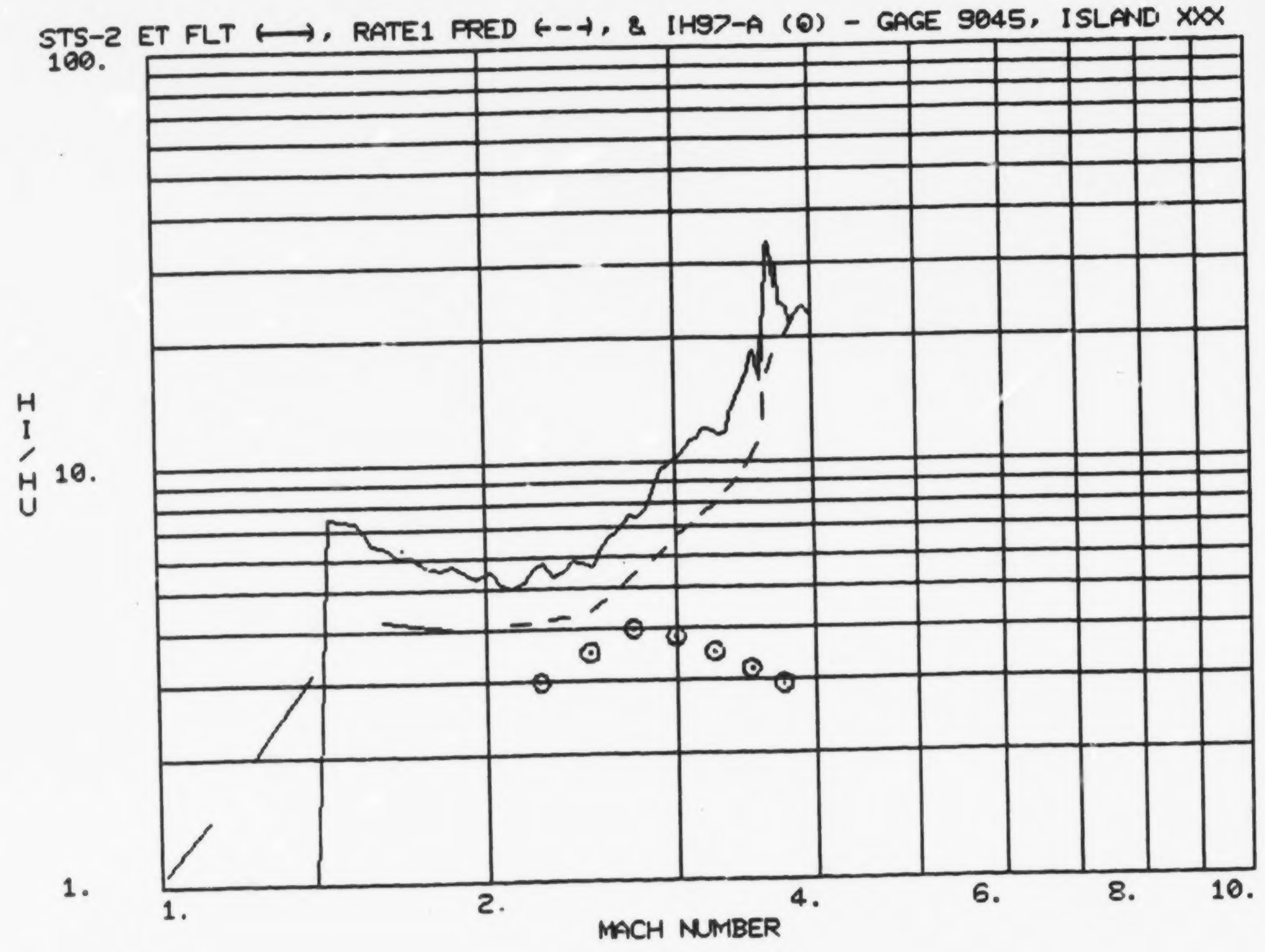
1.
0.1
HI/HU
1.
2.
4.
6.
8.
10.
MACH NUMBER

STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (0) - GAGE 9042, ISLAND XXX



NOTE: No IH-97A Data


STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9045, ISLAND XXX
100.
10.
1.
H I / H U
1.
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4.
6.
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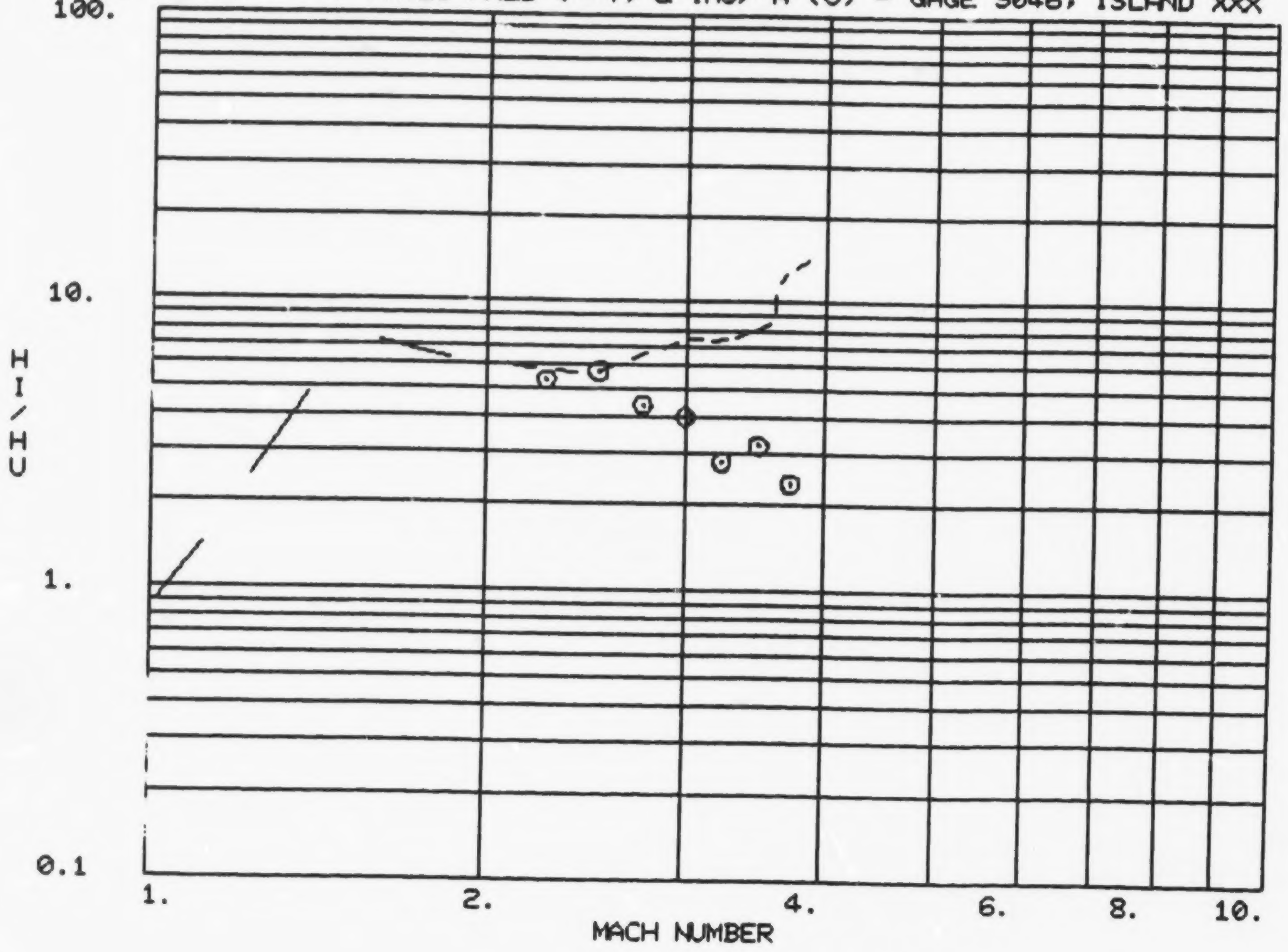
10.
MACH NUMBER

STS-2 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9046, ISLAND XXX



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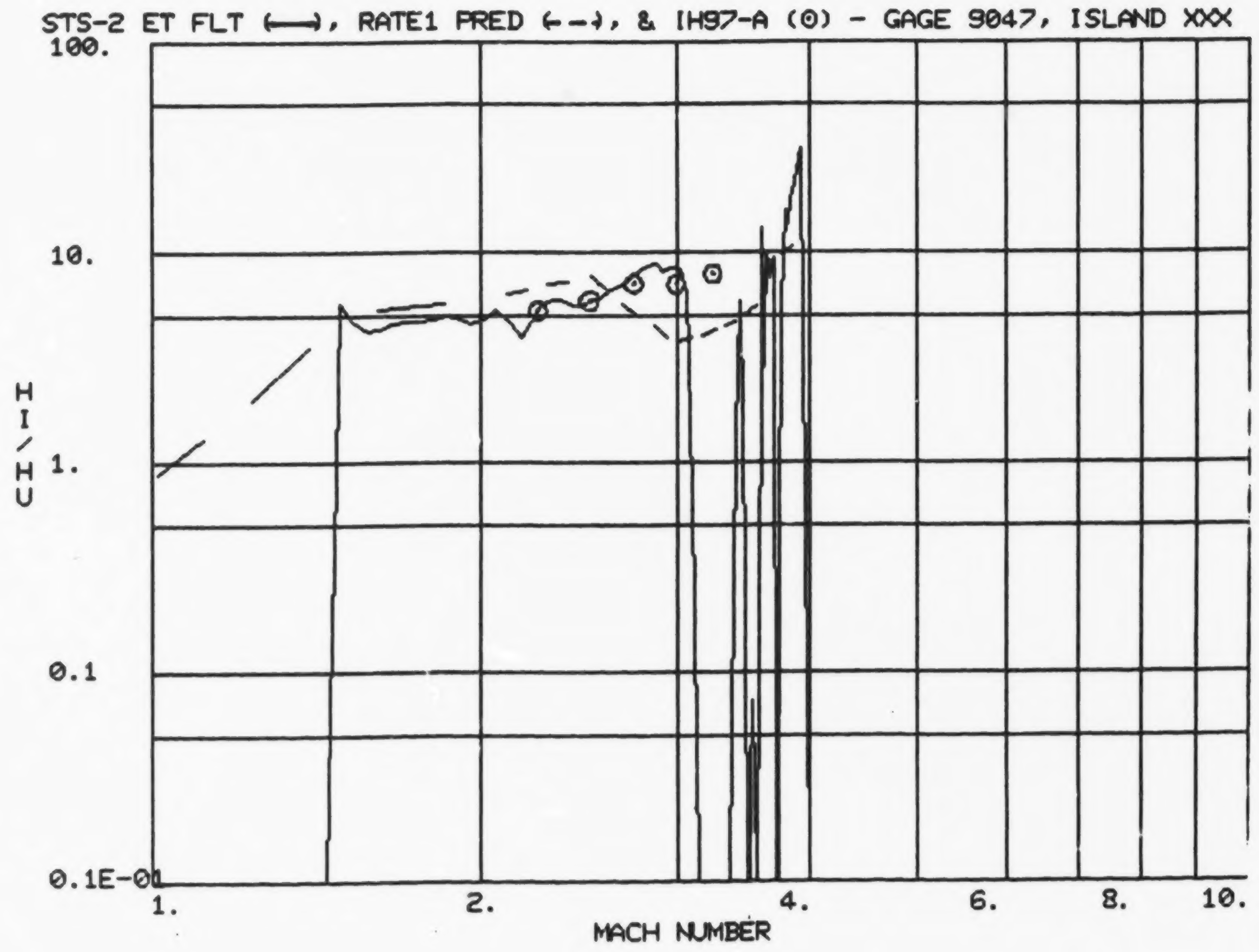
STS-2 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9047, ISLAND XXX
100.
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0.1
0.1E-01
H I / H U
1.
2.
4.
6.
8.
10.
MACH NUMBER

REMTECH INC.

SET-3

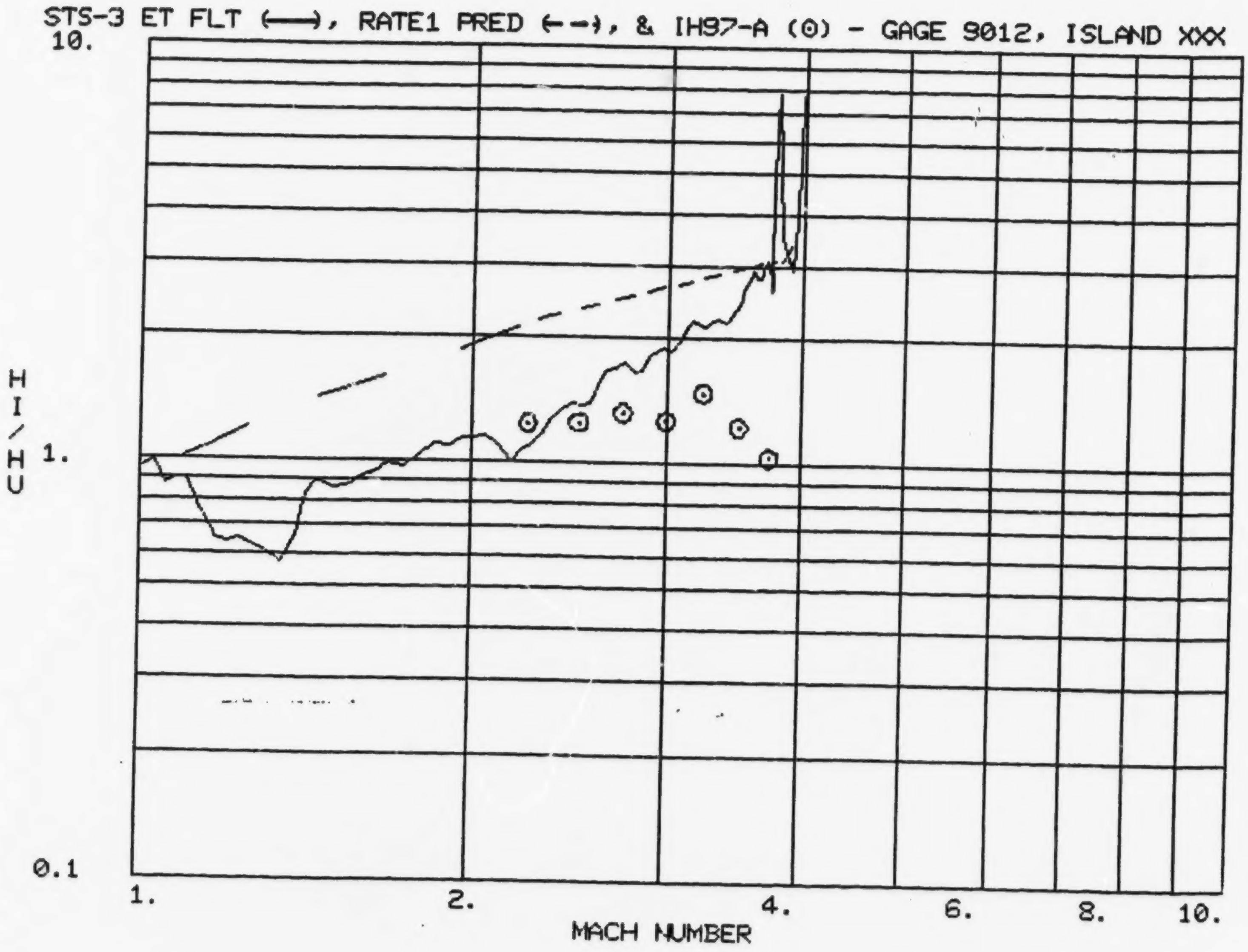
STS-2 pp. 3.1 - 3.10

Table 3.1 STS-3 PROTUBERANCE DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2054.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2030.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

TABLE 3.2 STS-3 ET INTERFERENCE FACTORS FOR PROTUBERANCE POINTS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75
9012	5053	1.233	1.243	1.313	1.260	1.467	1.222	1.034
9038	5054	1.640	1.232	1.239	1.219	1.207	4.363	4.495
9039	5057	—	—	—	—	—	—	—
9040	5055	1.409	1.394	1.586	1.796	1.774	2.168	2.044
9041	5058	10.373	12.418	14.843	17.594	19.888	25.222	26.458
9042	5059	—	—	—	—	—	—	—
9043	5056	1.885	—	—	—	—	—	—
9045	5060	2.801	2.719	2.904	2.812	2.778	2.392	2.397
9046	5061	7.764	9.618	9.491	4.734	4.863	2.361	2.572
9047	5062	3.284	3.958	4.185	5.286	10.009	—	—


STS-3 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9012, ISLAND XXX
HI/HU
10.
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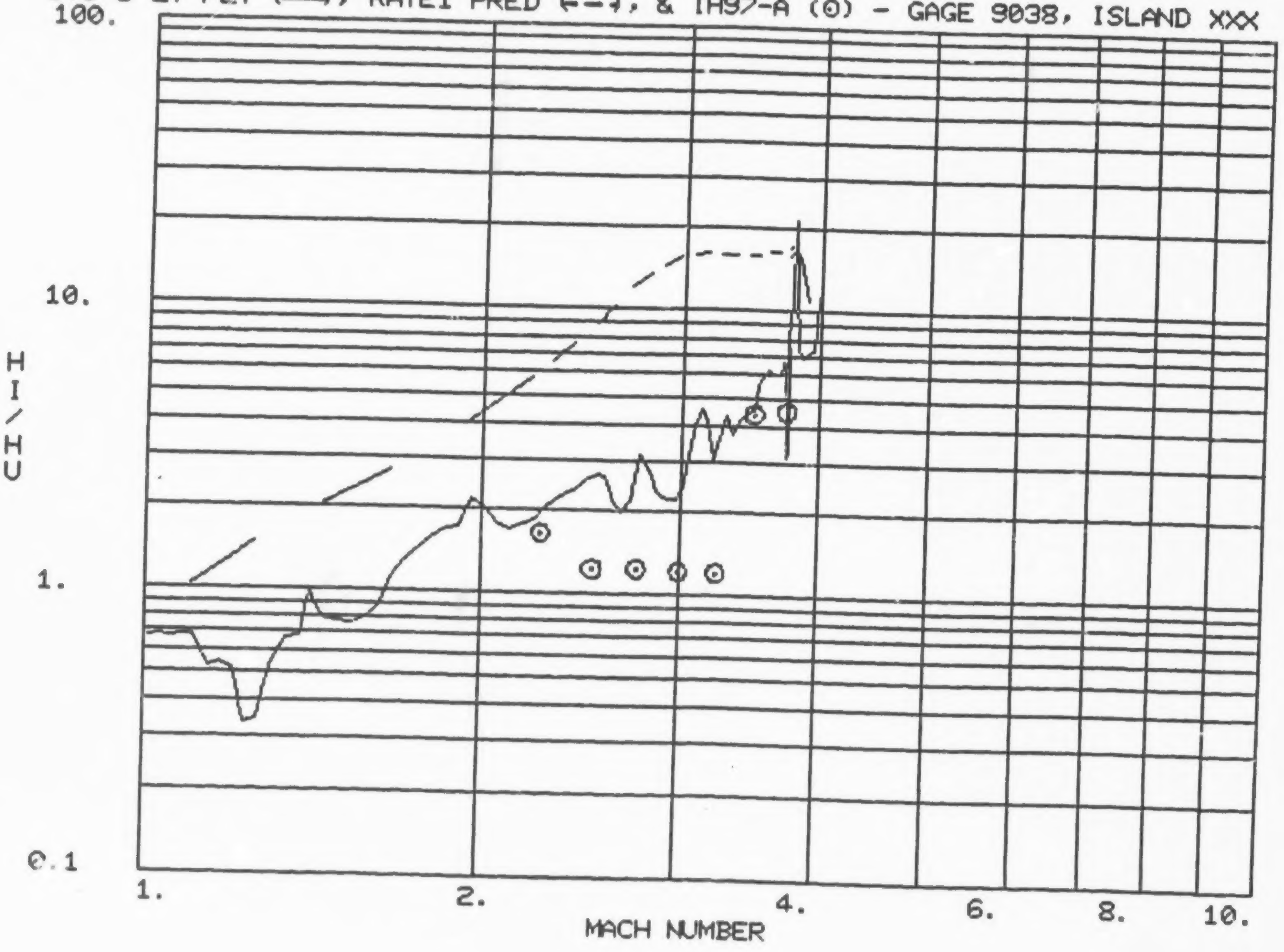
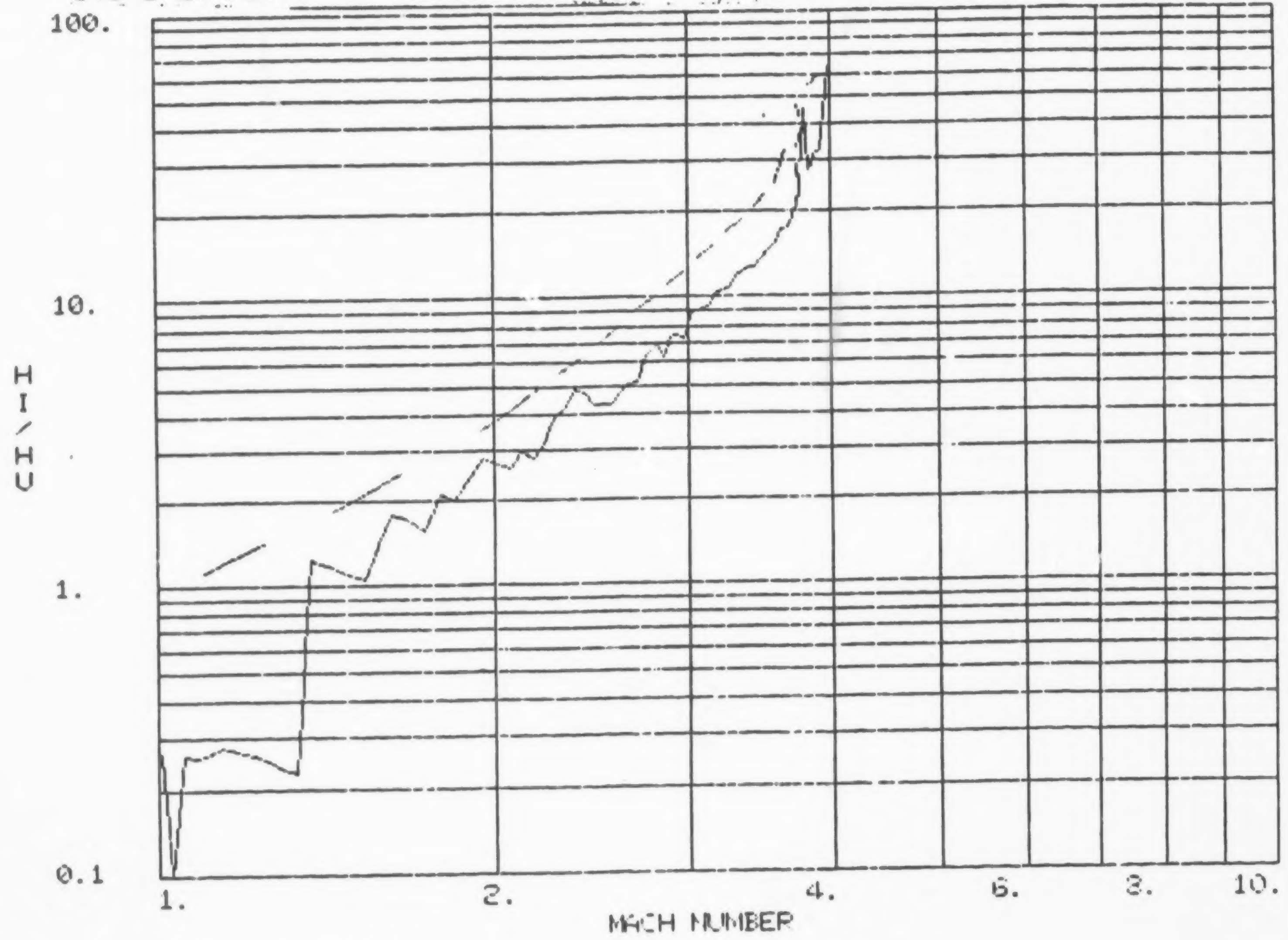
MACH NUMBER

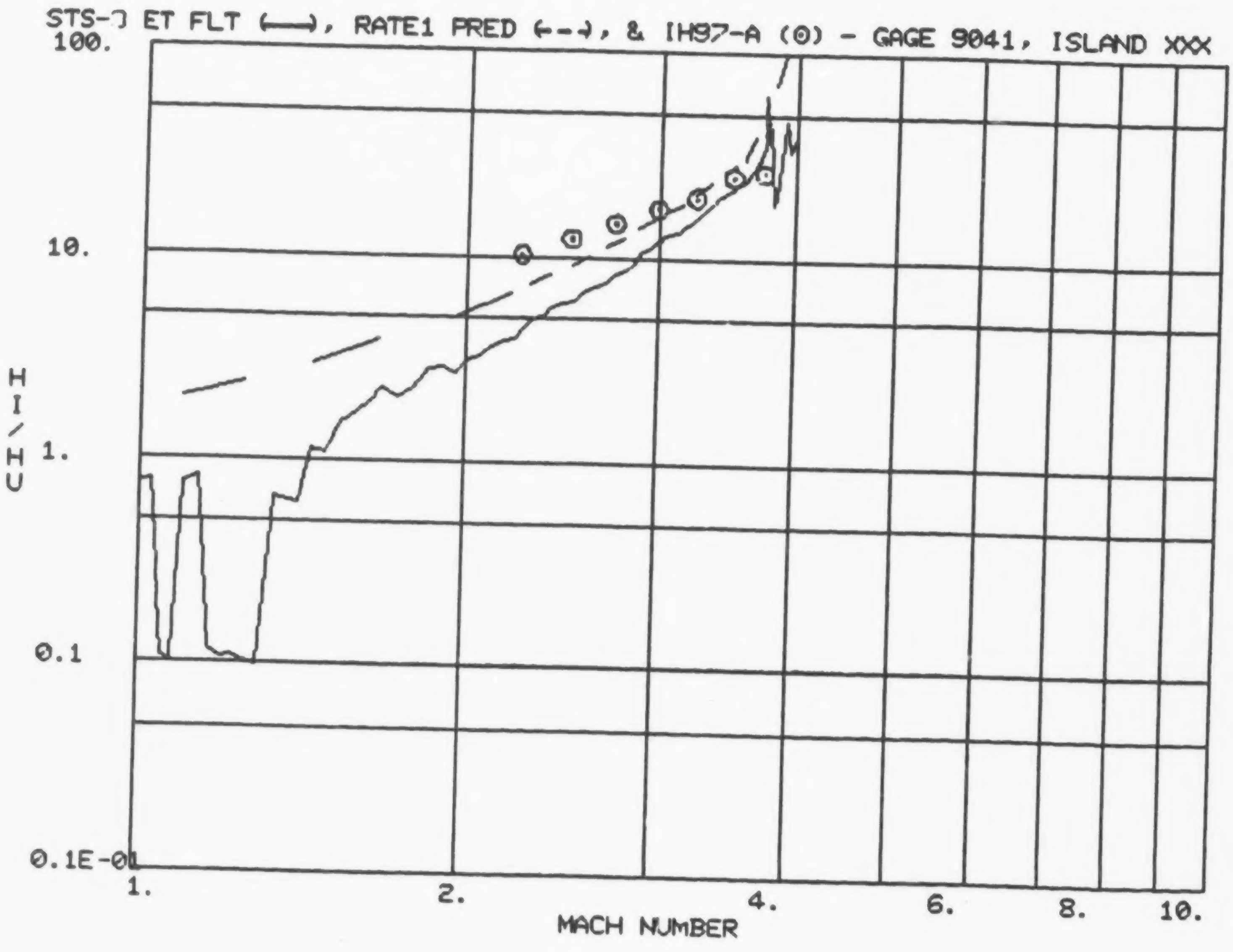
STS-3 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9038, ISLAND XXX



STS-3 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9039, ISLAND XXX



NOTE: No IH-97A Data


STS-? ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9041, ISLAND XXX
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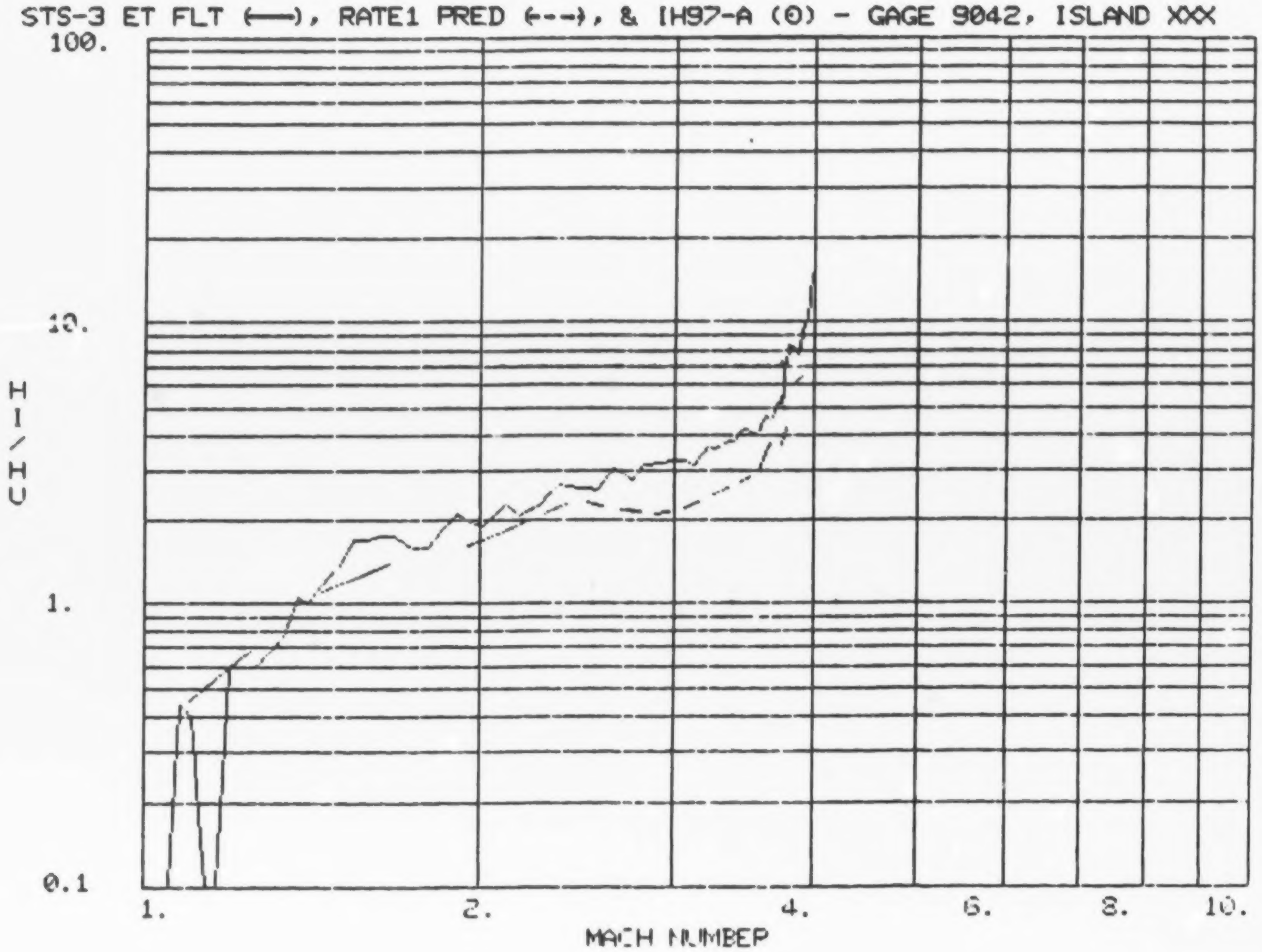
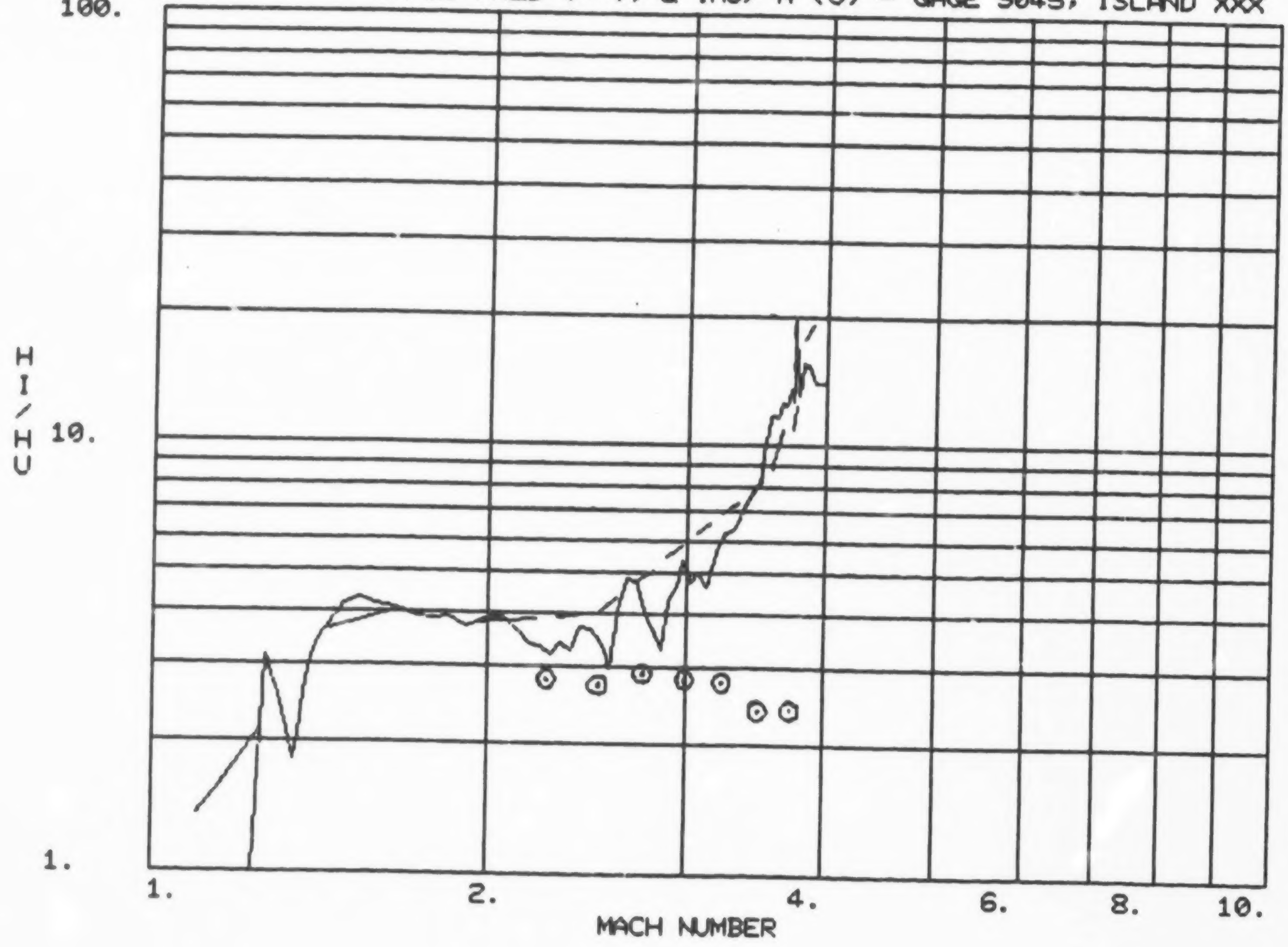


NOTE: No IH-97A Data

STS-3 ET FLT (——), RATE1 PRED (- - -), & IH97-A (⊙) - GAGE 9045, ISLAND XXX



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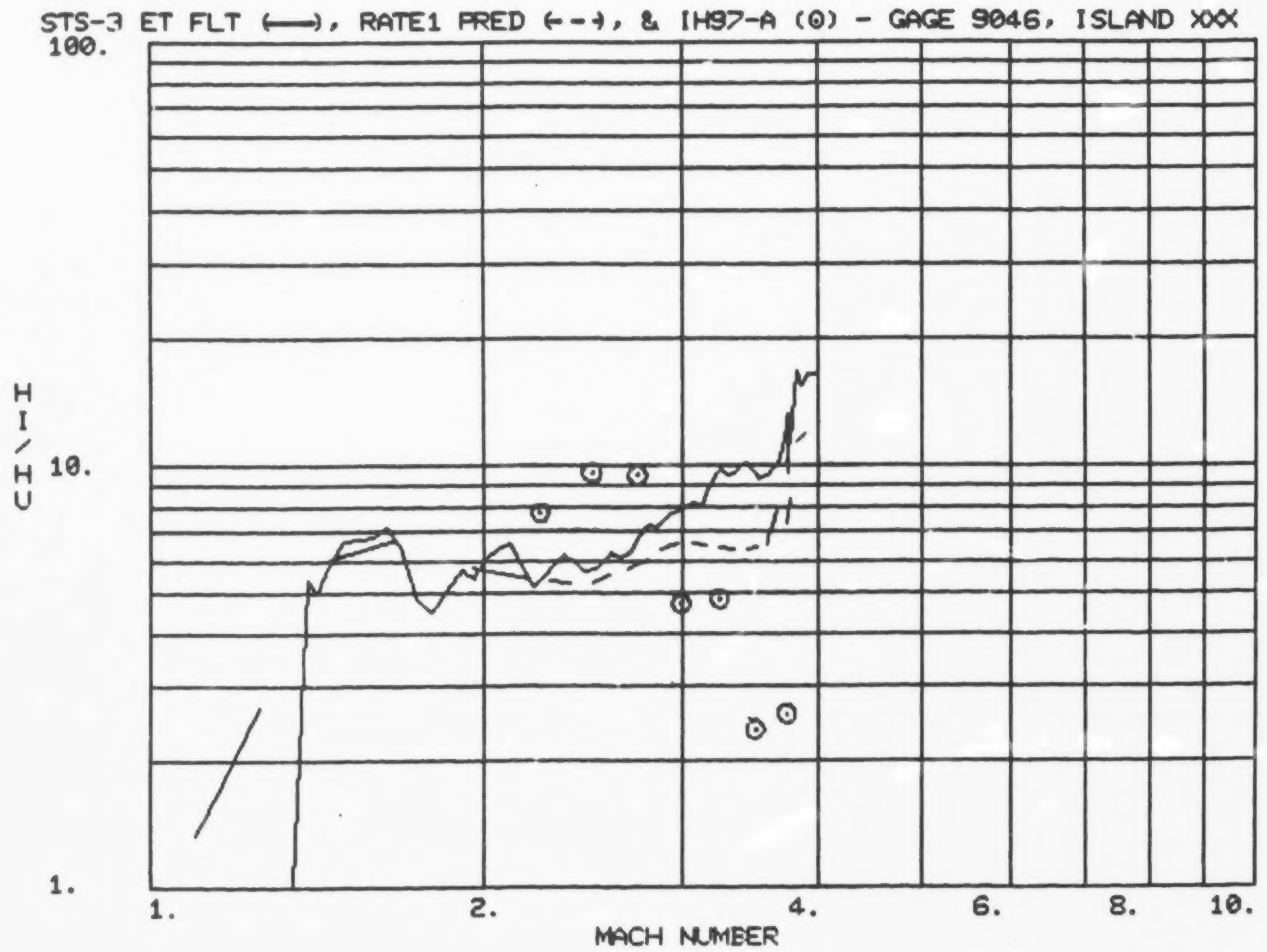

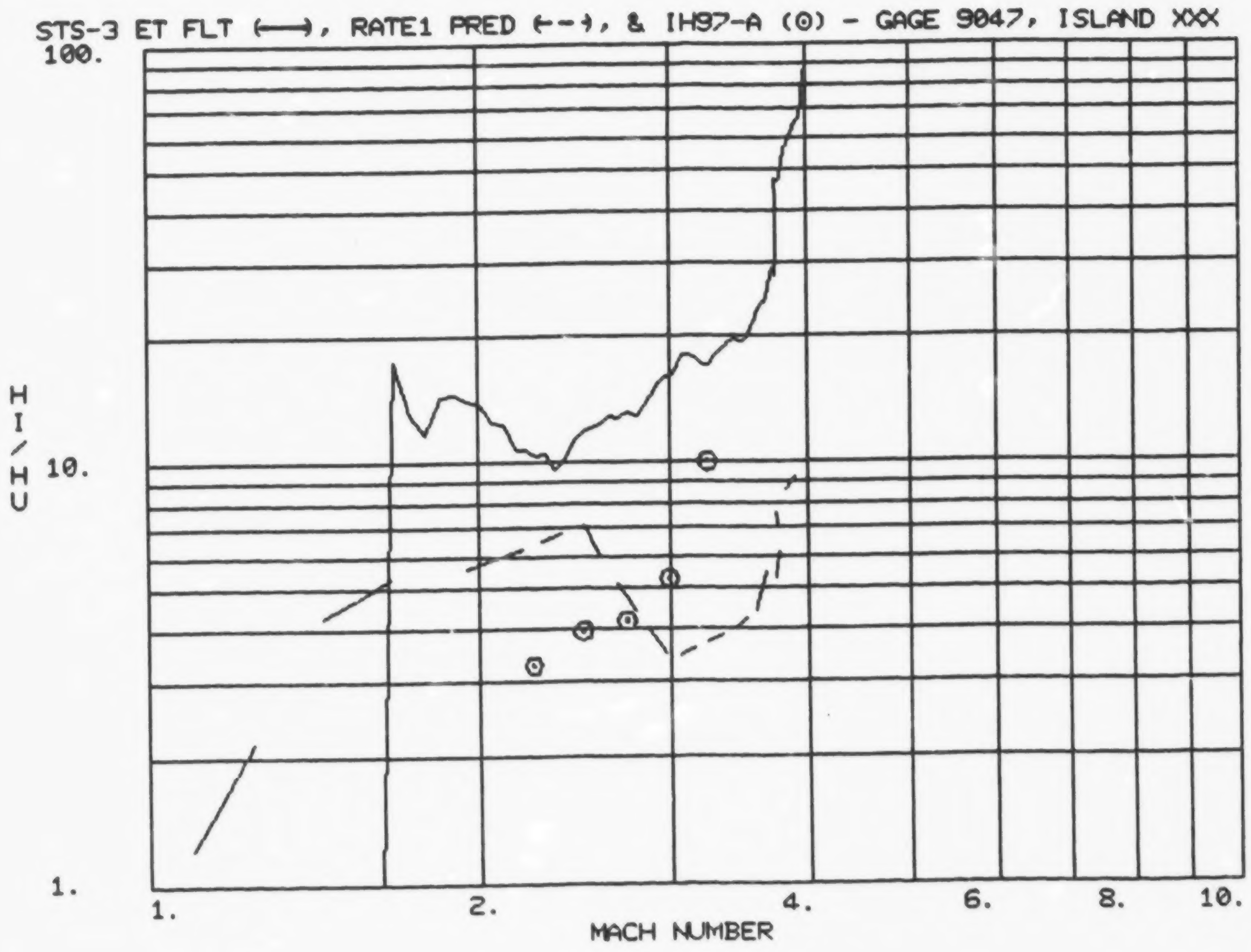
STS-3 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9047, ISLAND XXX
H/HU
100.
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MACH NUMBER

REMTECH INC.

SET-4

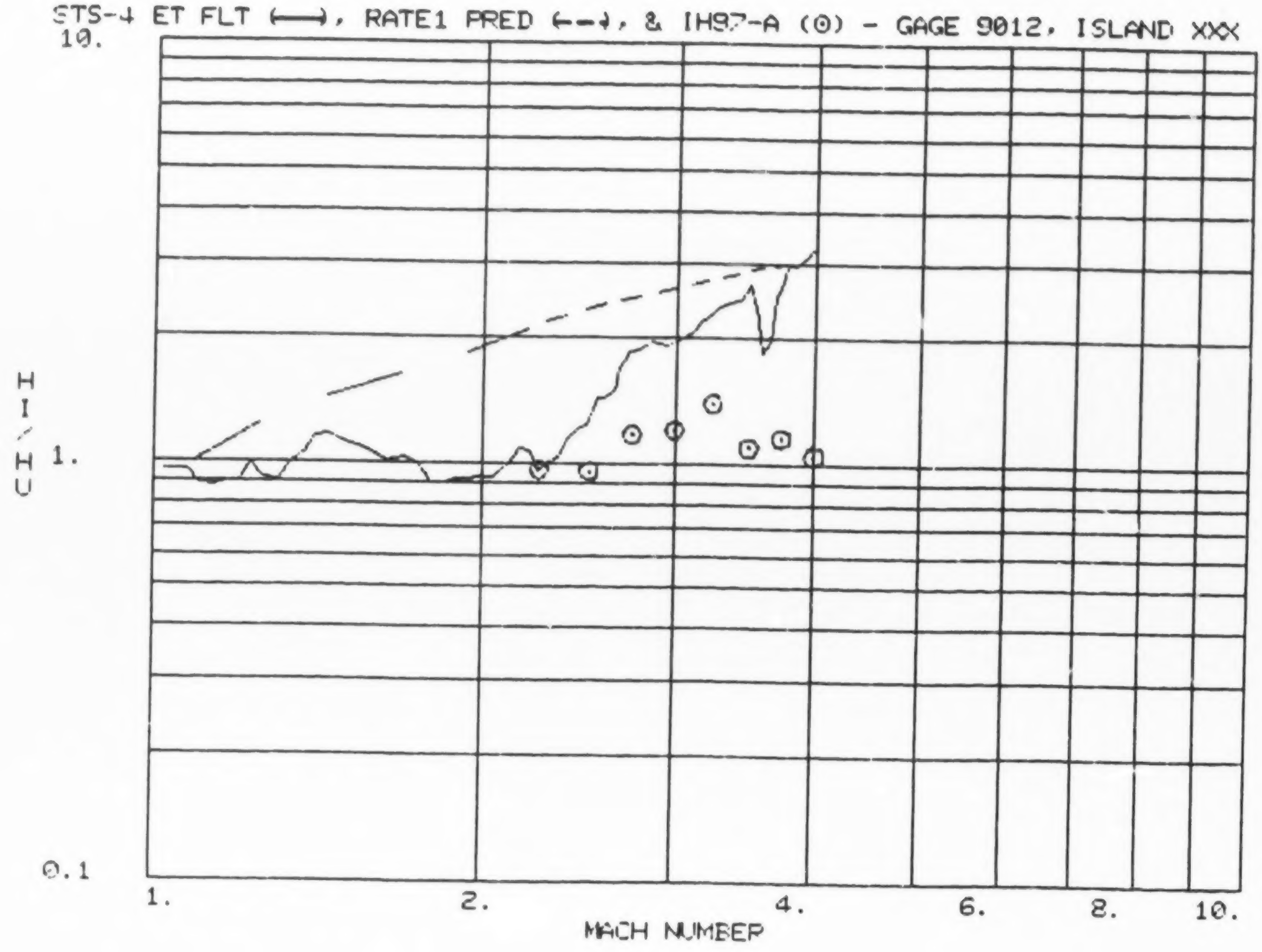
STS-4 pp. 4.1 - 4.10

Table 4.1 STS-4 PROTUBERANCE DFI LOCATIONS

MEASUREMENT I.D.	XT (IN.)	THETA (DEG.)	GAGE TYPE	LOCATION
T07R9012A	1008.0	21.0	Ind. Gage	LO2 Fdln. Fairing (side)
T07R9038A	996.0	23.0	Ind. Gage	LO2 Fdln. Fairing (top)
T07R9039A	1129.9	356.0	Ind. Gage	ET/ORB Fwd LH Strut
T07R9041A	959.2	270.0	Ind. Gage	Bolt Catcher
T07R9042A	2002.0	29.0	Ind. Gage	RH Thrust Strut
T07R9045A	2058.0	10.0	Ind. Gage	Aft Diag. Strut
T07R9046A	2054.0	45.0	Ind. Gage	LH Vert Strut Cable Tray
T07R9047A	2030.0	26.0	Ind. Gage	Fwd. LO2 Fdln/X-Beam Cable Tray

TABLE 4.2 STS-4 ET INTERFERENCE FACTORS FOR PROTUBERANCE POINTS FROM THE IH-97A WIND TUNNEL DATA BASE

FLIGHT GAGE NO.	IH97A GAGE NO.	HI/HU @ MACH NUMBER 2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
9012	5053	0.968	0.960	1.167	1.199	1.386	1.092	1.150	1.047
9038	5054	2.482	2.245	1.712	2.416	2.689	4.722	4.829	4.601
9039	5057	——	——	——	——	——	——	——	——
9040	5055	1.658	1.715	1.496	1.850	1.919	2.115	2.228	2.184
9041	5058	9.733	12.339	14.908	18.829	21.685	25.807	27.188	30.823
9042	5059	——	——	——	——	——	——	——	——
9043	5056	1.183	——	——	——	——	——	——	——
9045	5060	2.698	2.738	——	3.397	1.828	2.316	2.611	3.655
9046	5061	5.500	4.290	3.150	4.039	2.113	2.162	10.982	4.627
9047	5062	3.444	4.967	5.439	7.759	——	——	——	——


STS-4 ET FLT (——), RATE1 PRED (– –), & IH97-A (⊙) - GAGE 9012, ISLAND XXX
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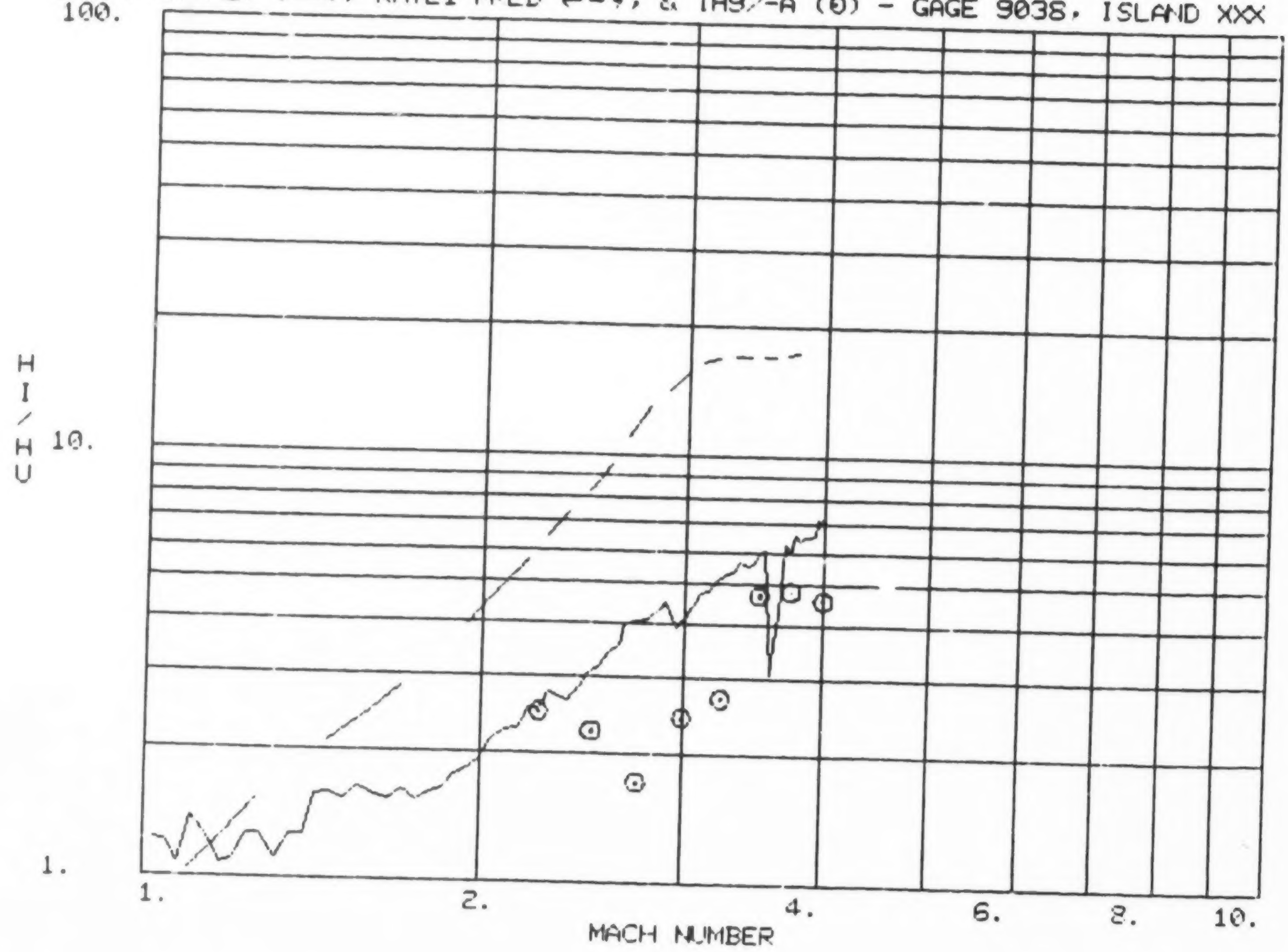
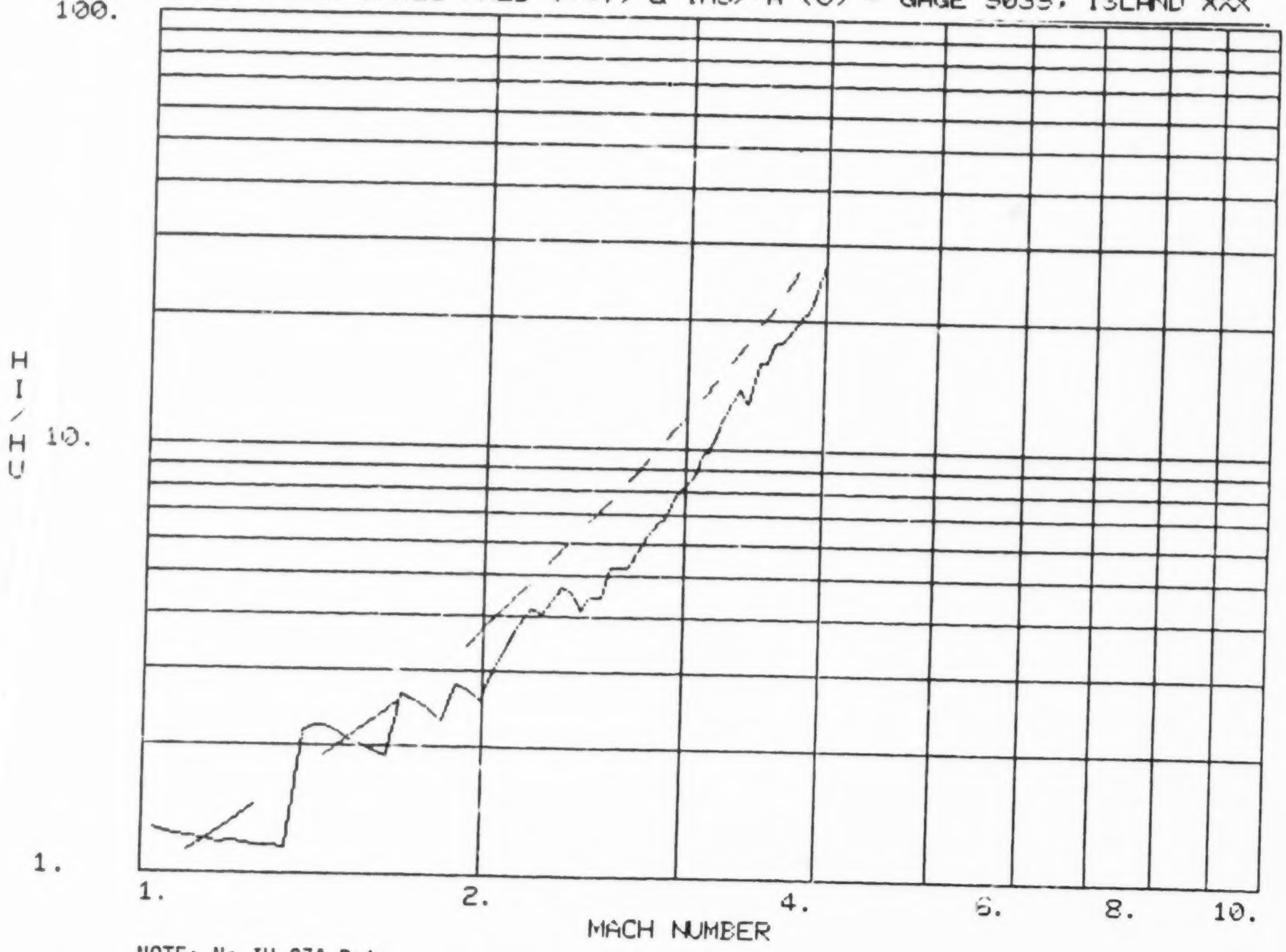
MACH NUMBER

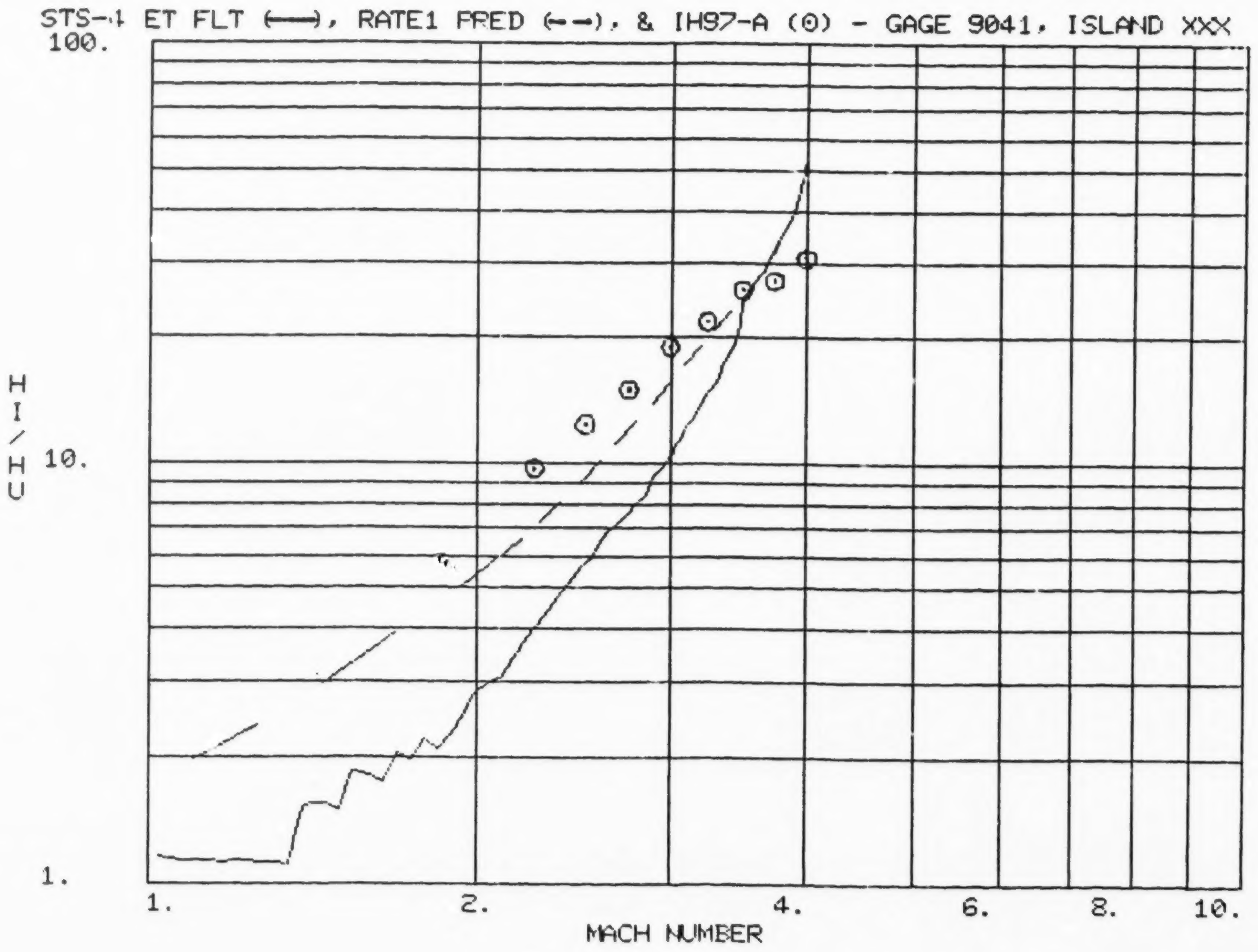
STS-4 ET FLT (——), RATE1 PRED (– – –), & IH97-A (⊙) - GAGE 9038, ISLAND XXX



STS-4 ET FLT (——), RATE1 FRED (– –), & IH97-A (O) - GAGE 9039, ISLAND XXX



NOTE: No IH-97A Data


STS-1 ET FLT (——), RATE1 FRED (– –), & IH97-A (⊙) - GAGE 9041, ISLAND XXX
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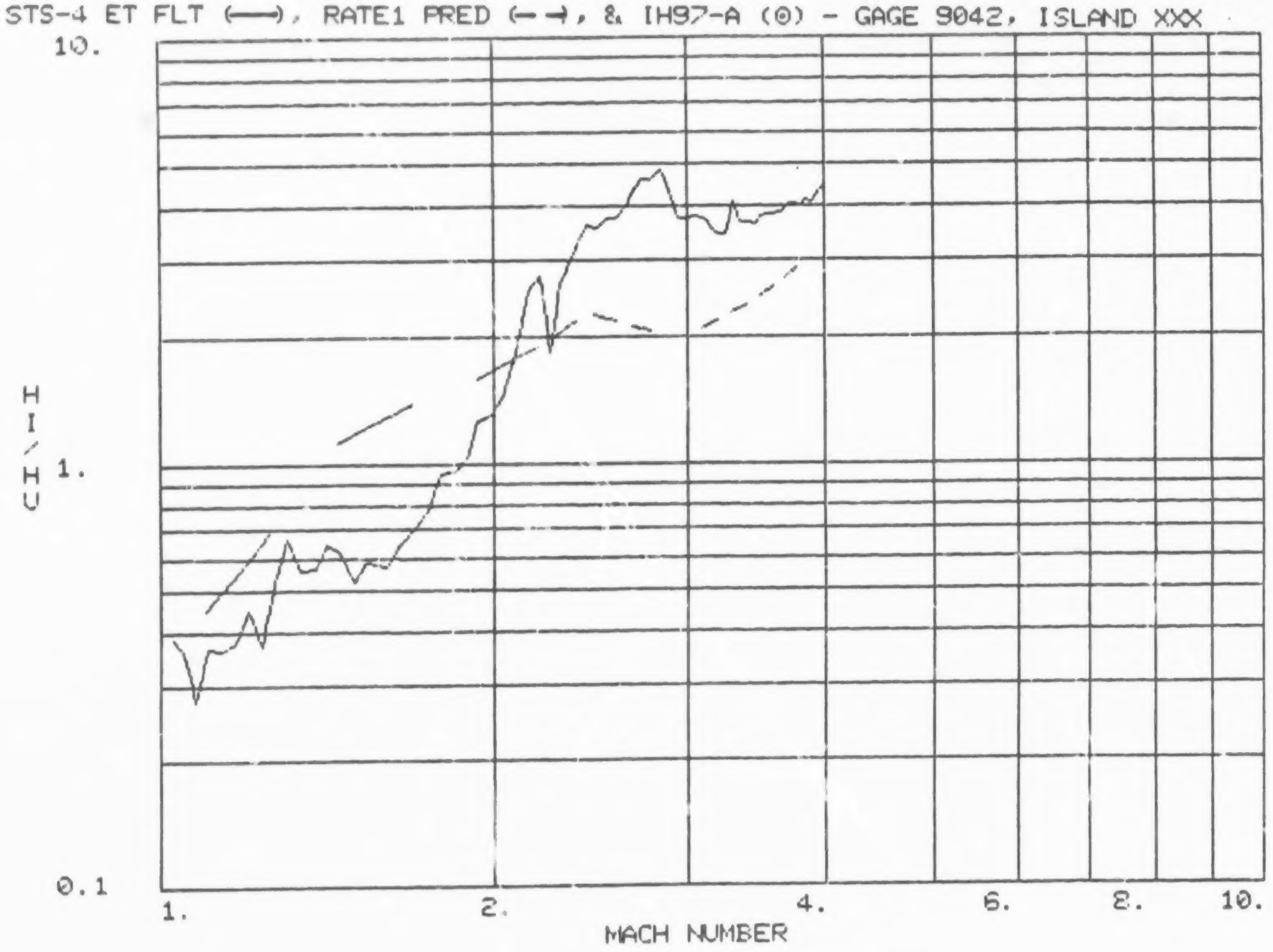
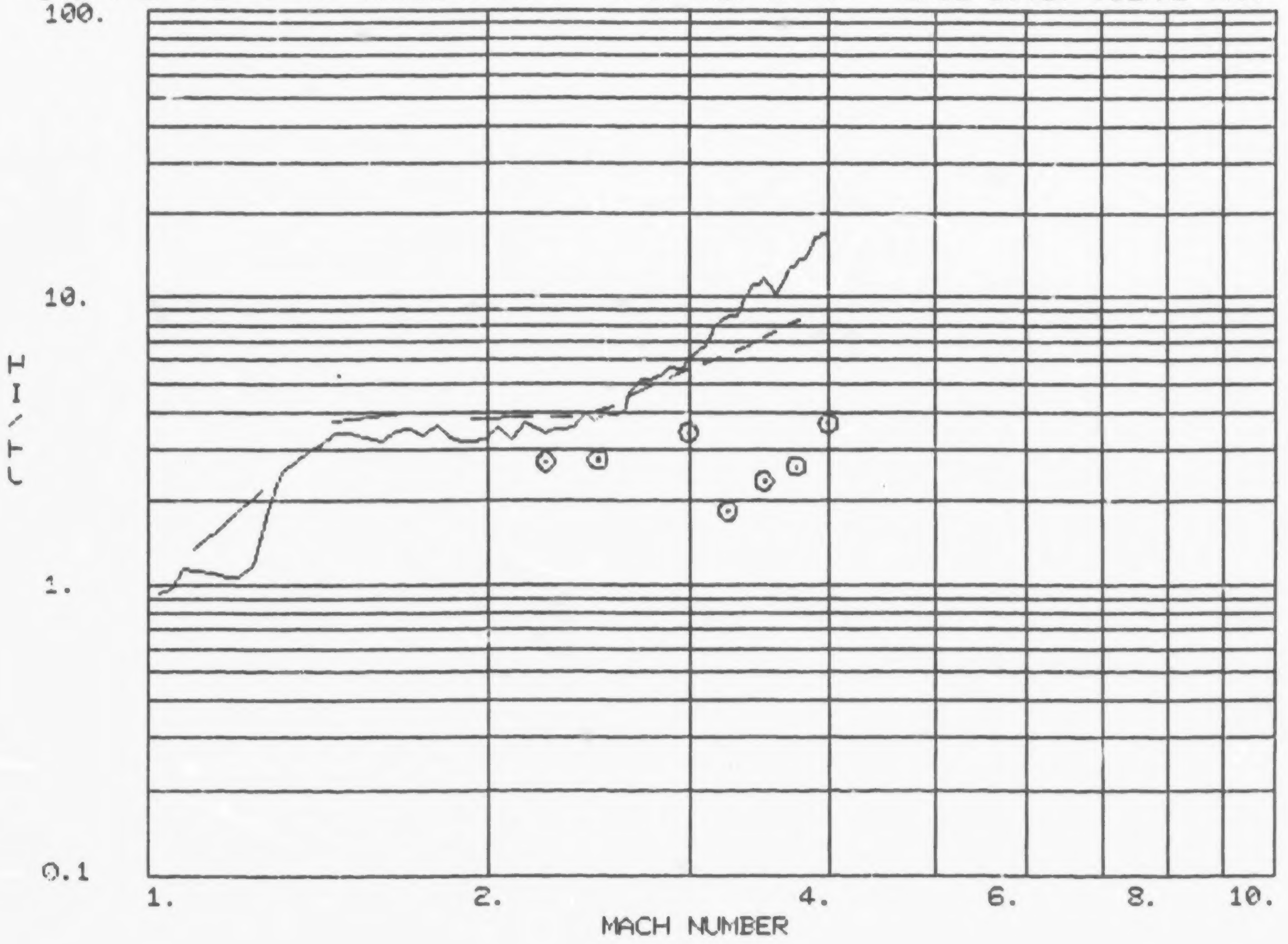
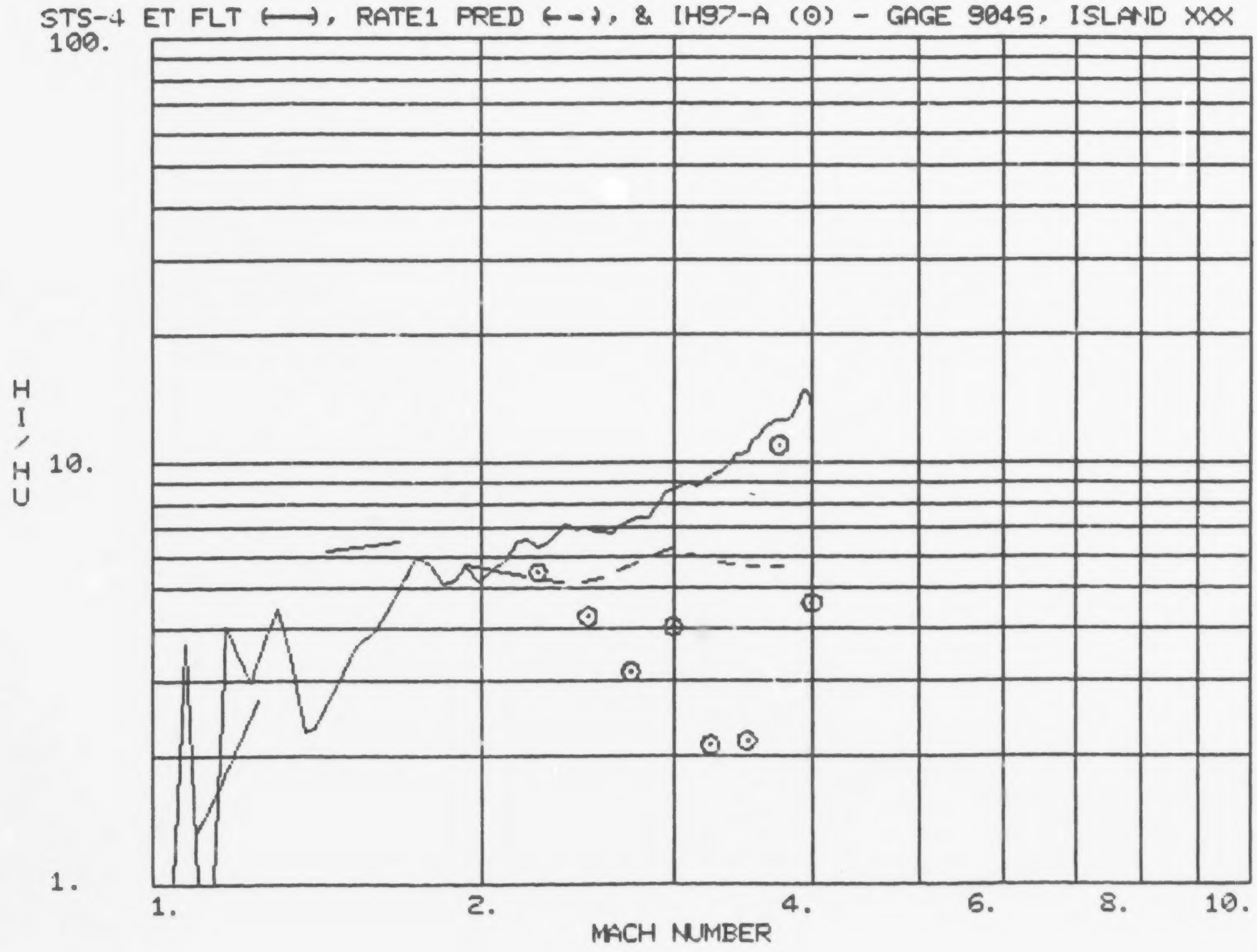
MACH NUMBER



NOTE: No IH-97A Data

STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9045, ISLAND XXX




STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9045, ISLAND XXX
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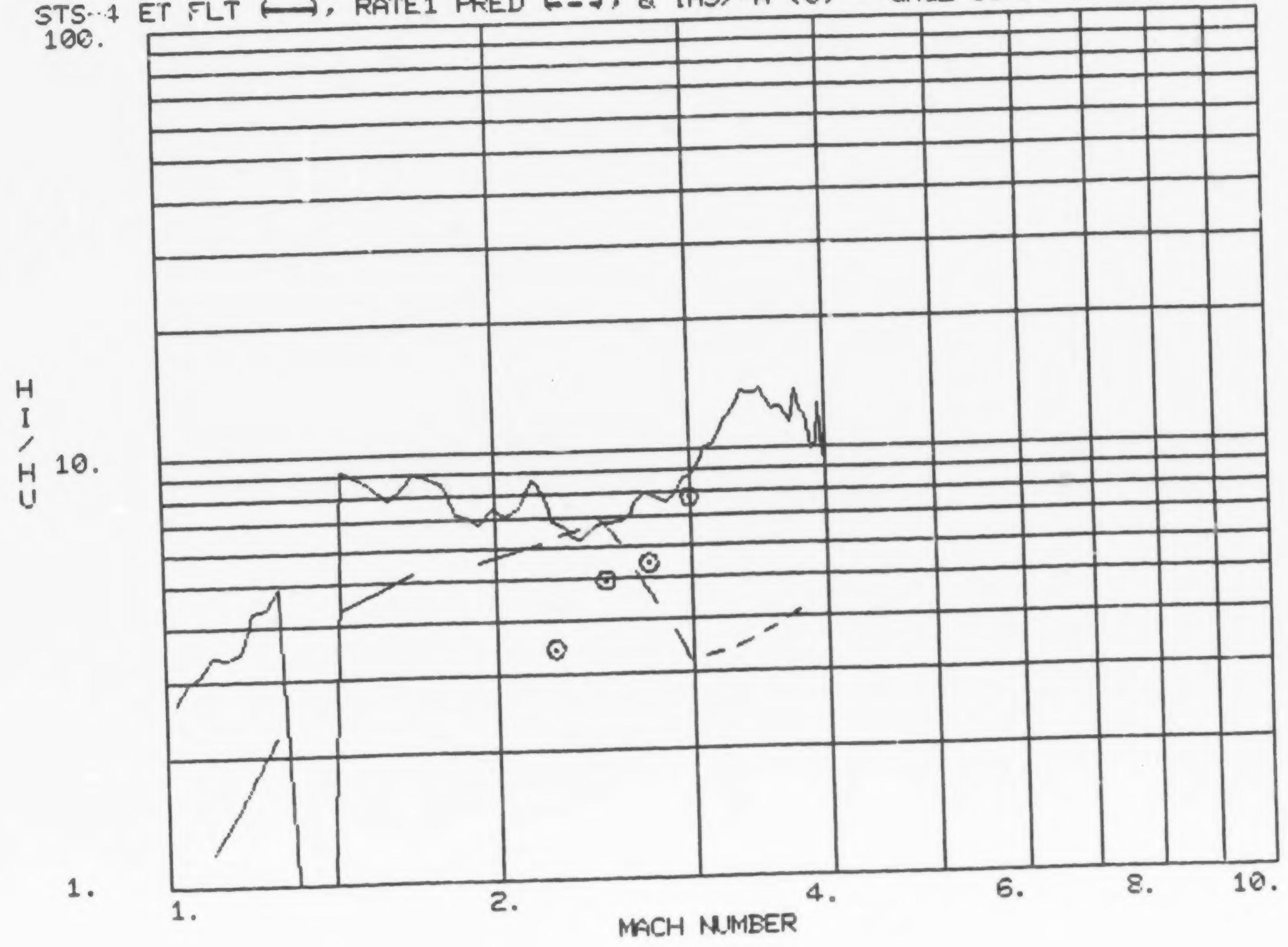
MACH NUMBER

STS-4 ET FLT (——), RATE1 PRED (- -), & IH97-A (⊙) - GAGE 9047, ISLAND XXX



APPENDIX D

FREESTREAM STANTON NUMBER AND REYNOLDS NUMBER CORRELATION FOR FLIGHT AND TUNNEL DATA

REMTECH INC.

TITLE: Wind Tunnel And Flight Data For The ET In The Form Of Free-stream Stanton Number As A Function Of Reynolds Number (From RTN 032-18)

DATE: May 1984

AUTHORS: John D. Warmbrod
Amanda L. Boyd

CONTRACT NO: NAS8-32969

PREPARED FOR: George C. Marshall Space Flight Center

Introduction

In the year 1874, Osborne Reynolds published a paper which suggested that momentum and heat in a fluid are transferred in the same way. He showed for incompressible flow that the non-dimensional form of the momentum and heat transfer equations are directly proportional where the non-dimensional quantities are defined below:

Momentum - Skin Friction Coef. $$C_f = \frac{\tau_W}{1/2 \frac{\rho}{g} V^2} \approx Re$$

Heat Transfer - Stanton Number $$St = \frac{\dot{q}}{\rho V (H - H_W)} = \frac{h}{\rho V} \approx Re$$

where

τw = Wall Shear Stress, lb_f/ft^2

ρ = Density (Free-stream or Edge), lb_m/ft^3

V = Velocity (Free-stream or Edge), ft/sec

Re = Reynolds Number Based On Running Length

$\dot{q}$ = Heat Flux Into Wall, $Btu/ft^2 sec$

h = Heat Transfer Coefficient, $lbm/ft^2 sec$

H = Enthalpy (Recovery or Total),

H_W = Wall Enthalpy, Btu/lb_m

Reynolds's original expression for the analogy between heat transfer and skin friction for incompressible flow was

$$St = \frac{C_f}{2S}$$

where S is called the Reynolds Analogy Factor. Reynolds assigned a value of S = 1 whereas, other definitions for S have been subsequently developed (Colburn, Karman, Kozlov, Spaulding and Chi).

Various authors have shown that theoretical and experimental results for the Stanton number exhibit the following trends with Reynolds Number for laminar and turbulent boundary layers.

Laminar	$St\ (Re)^{1/2} \simeq$ Constant
Turbulent	$St\ (Re)^{1/5} \simeq$ Constant

Another way of collapsing heat transfer data has been in the form of the Nusselt Number which is defined by

$$N_u = \frac{C_p hS}{K} = Re \cdot Pr \cdot St$$

where

C_p = Specific Heat ($\simeq$ .24 for air), Btu/lb_m ^oR

h = Heat Transfer Coefficient, lb_m/ft^2sec

S = Running Length, ft

K = Thermal Conductivity, Btu/ftsec^oR

Pr = Prandtl Number ($\simeq$ .72 for Air)

Re = Reynolds Number Based On Running Length

The above non-dimensional parameters can be defined by using either free-stream or boundary layer edge properties.

Flight And Wind Tunnel Data Plots

The External Tank was instrumented to measure surface heat fluxes and pressures for Shuttle Missions STS 1-5 and 7. The flight heat transfer data measured on the nose cone, ogive, barrel ($X_T \leq 1500$) and selected protuberances were reduced to the form of Stanton Number and unit Reynolds Number based on free-stream properties. Table 1 shows the calorimeter locations and gage identifications along with the flights for which each calorimeter was installed. The heat transfer data measured by the calorimeters identified in Table 1 are presented in Figures 1-22 as free-stream Stanton Number as a function of free-stream Reynolds Number. The presentation of this data for Stanton Number and Reynolds Number as a function of boundary layer edge properties might further collapse the data since the angle of attack effects will be removed. One interesting observation made from the data presented in Figures 1-22 is that the data does not closely follow the turbulent trend ($St\ (Re)^{1/5} \simeq$ constant).

The primary objective of this memo is to document the reduction of the flight data in Stanton/Reynolds Number form. It is expected that this data might lead to alternative methodologies for predicting design environments on the External Tank.

TABLE 1: ET Flight Instrumentation For Which Heat Transfer Data Was Reduced To Stanton Number As A Function Of Reynolcs Number

Acreage Or Protuberance	Island	Gage	X_T (IN)	θ_T (DEG)	STS Flights	Location Description
Acreage	---	R9001	350	180.0	1,2,3,4,5,7	40° Cone
	1	9005	467.4	174.0	2,3,4,5,7	Ogive - LO_2
	2	9004	467.4	354.0		
	5	9008	672.5	180.0		
	6	9007	672.5	270.0		
	8	9010	825.5	270.0		Barrel - LO_2
	14	9016	937.4	251.4	1,2,3,4,5,7	Barrel - I/T
	15	9015	956.2	270		
	16	9014	937.4	288.6		
	17(1)	9019	1084.4	2.5		
	17(2)	9018	1098.5	2.5		
	17(3)	9013	1110.4	2.5		
	18	9011	976.0	25.0		
	23	9022	1082.0	180.0		
	26	9023	1130.3	0.0	4,5,7	Barrel - LH_2
	27	9020	1147.4	358.0	4,5,7	
	28	9026	1489.0	172.5	3,4,5,7	
Protuberance	---	9039	1130	---	1,2,3,4,5,7	Bi-Pod
	---	9041	959.3	---		Bolt Catcher
	---	9038	---	---		Feedline Fairing
	---	9042	---	---		Thrust Strut
	---	9040	1322.0	---	5	Cable Tray Top

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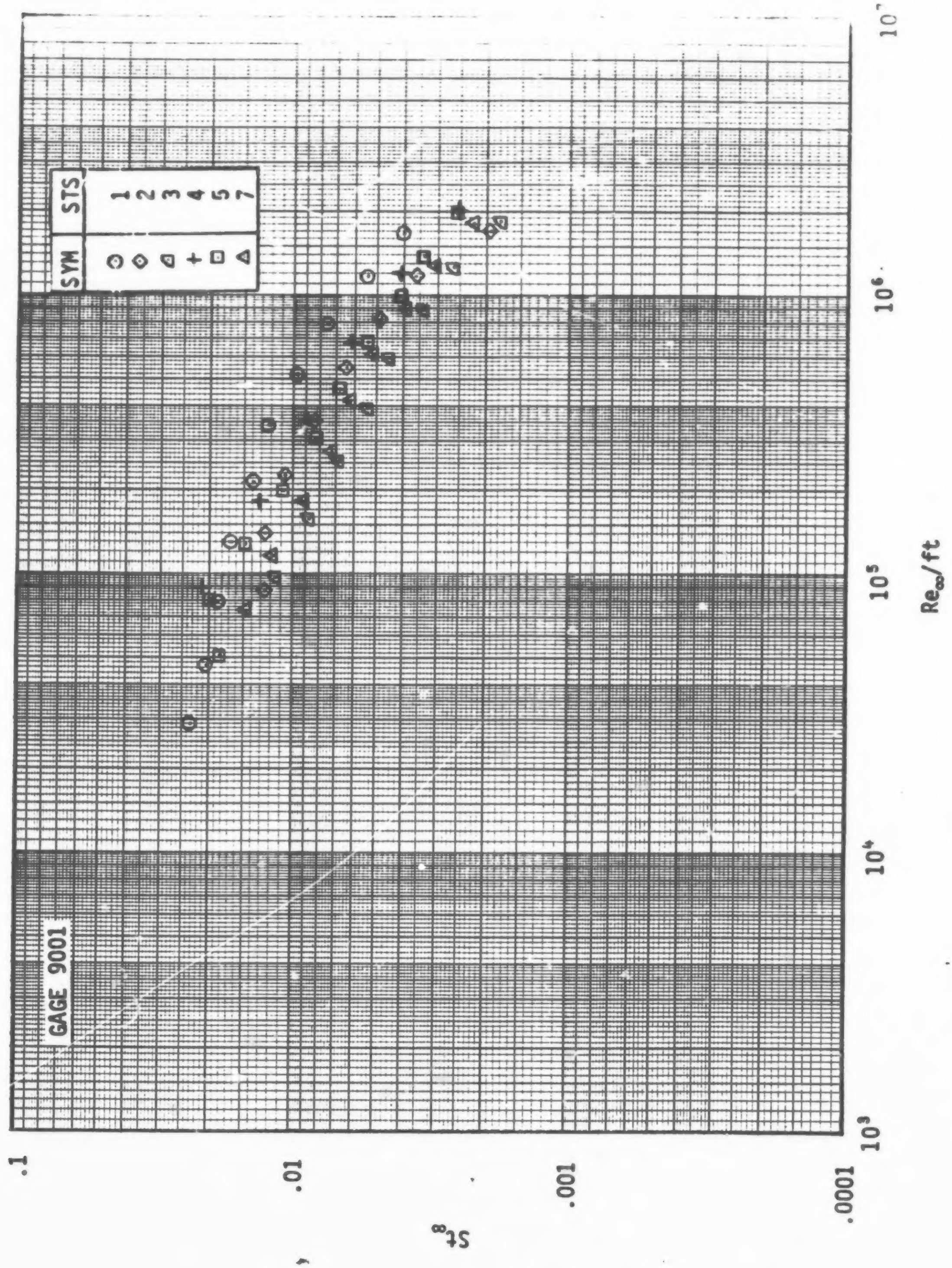

Fig.1 Stanton Number As A Function Of Reynolds Number For Gage 9001

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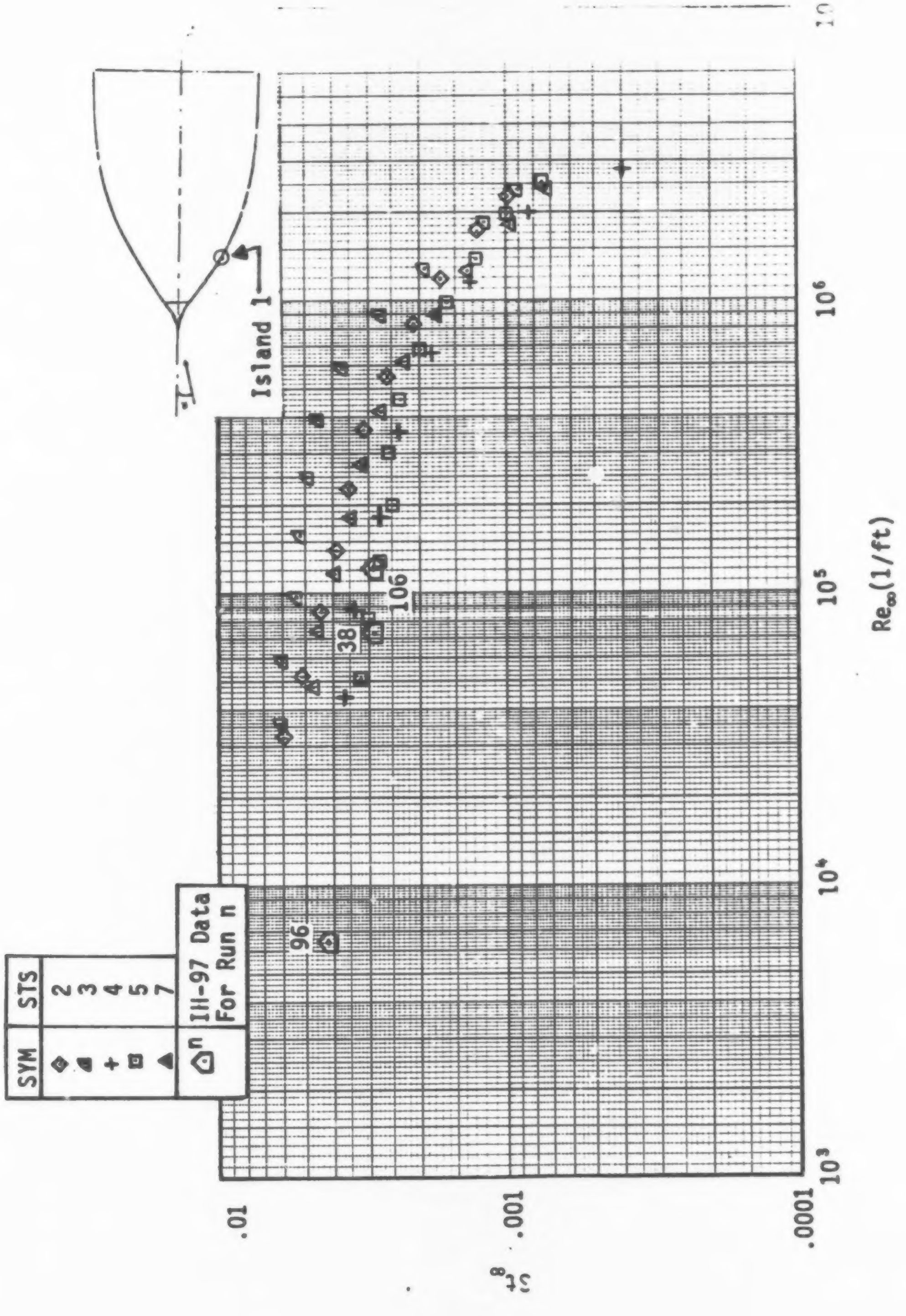

Fig.2 Stanton Number As A Function Of Reynolds Number For Island 1

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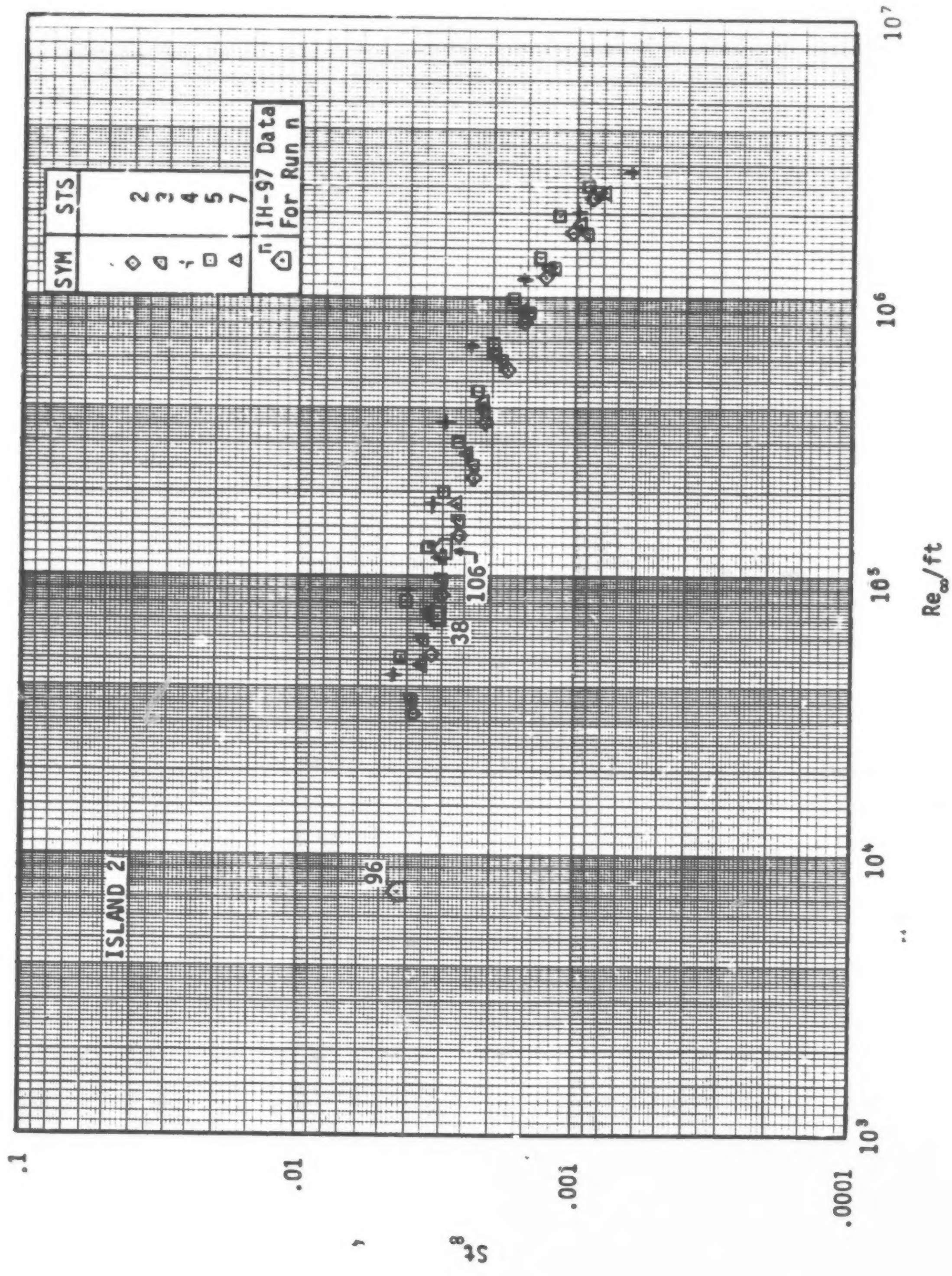

Fig. 3 Stanton Number As A Function Of Reynolds Number For Island 2

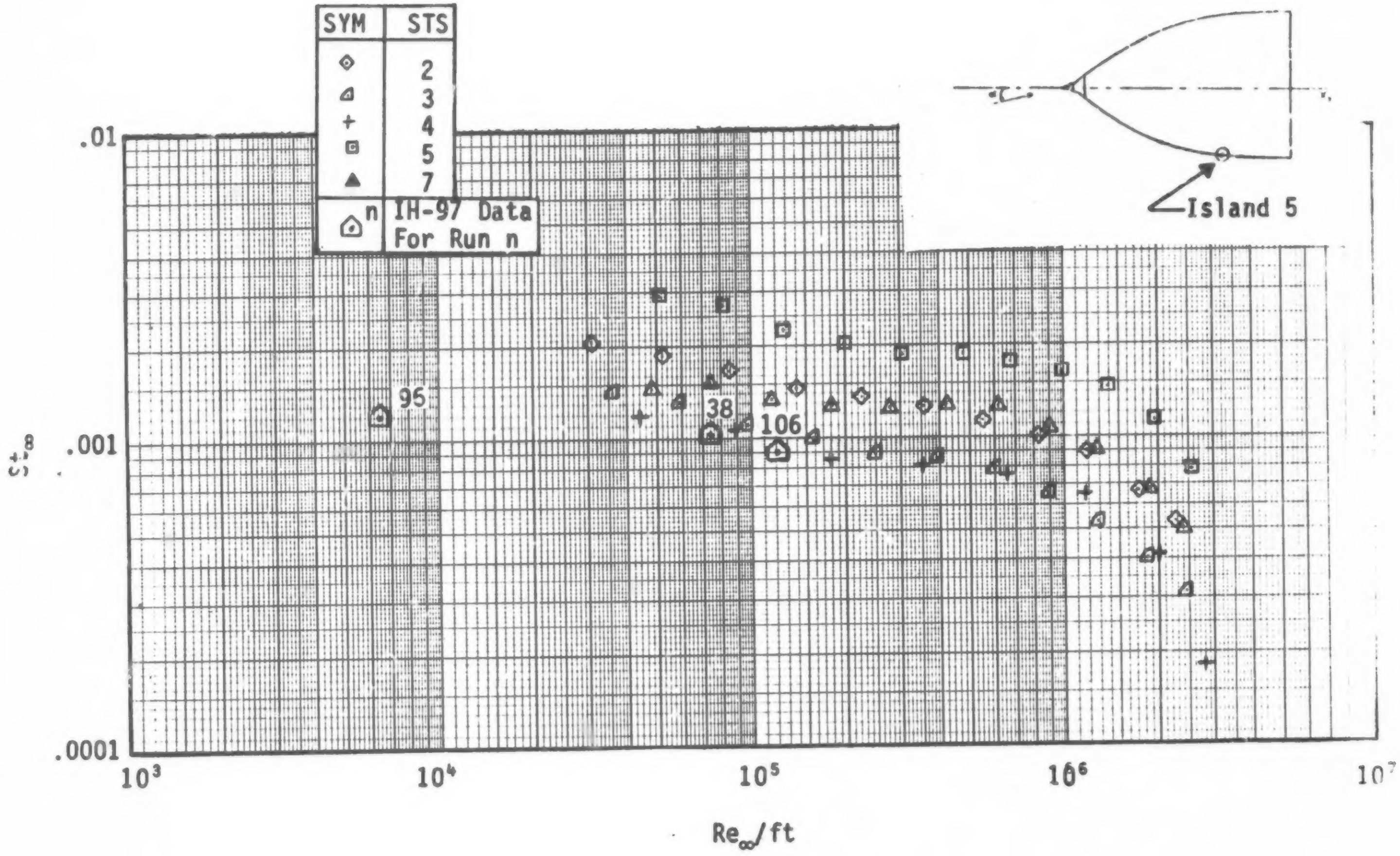

Fig.4 Stanton Number As A Function Of Reynolds Number For Island 5

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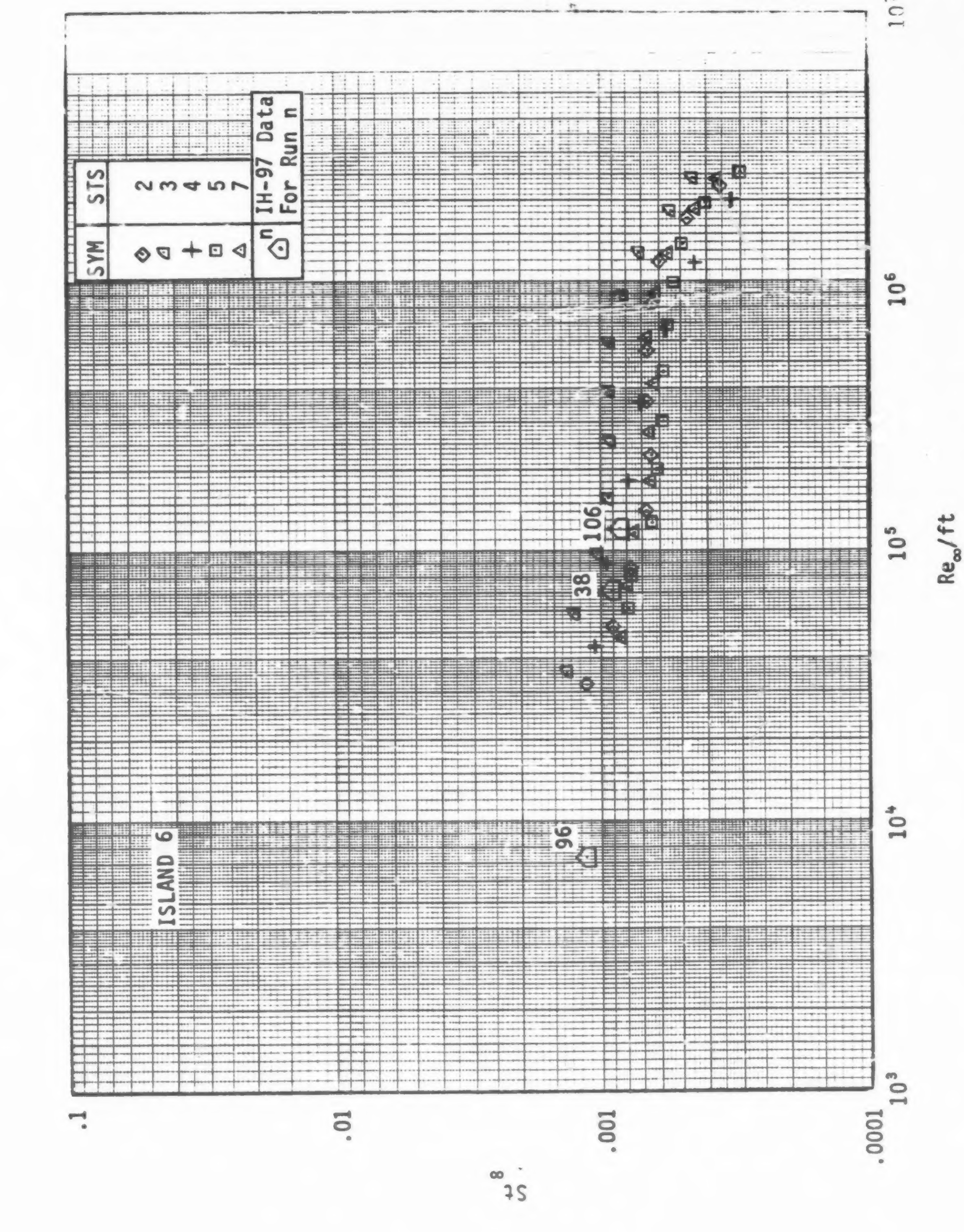

Fig.5 Stanton Number As A Function Of Reynolds Number For Island 6

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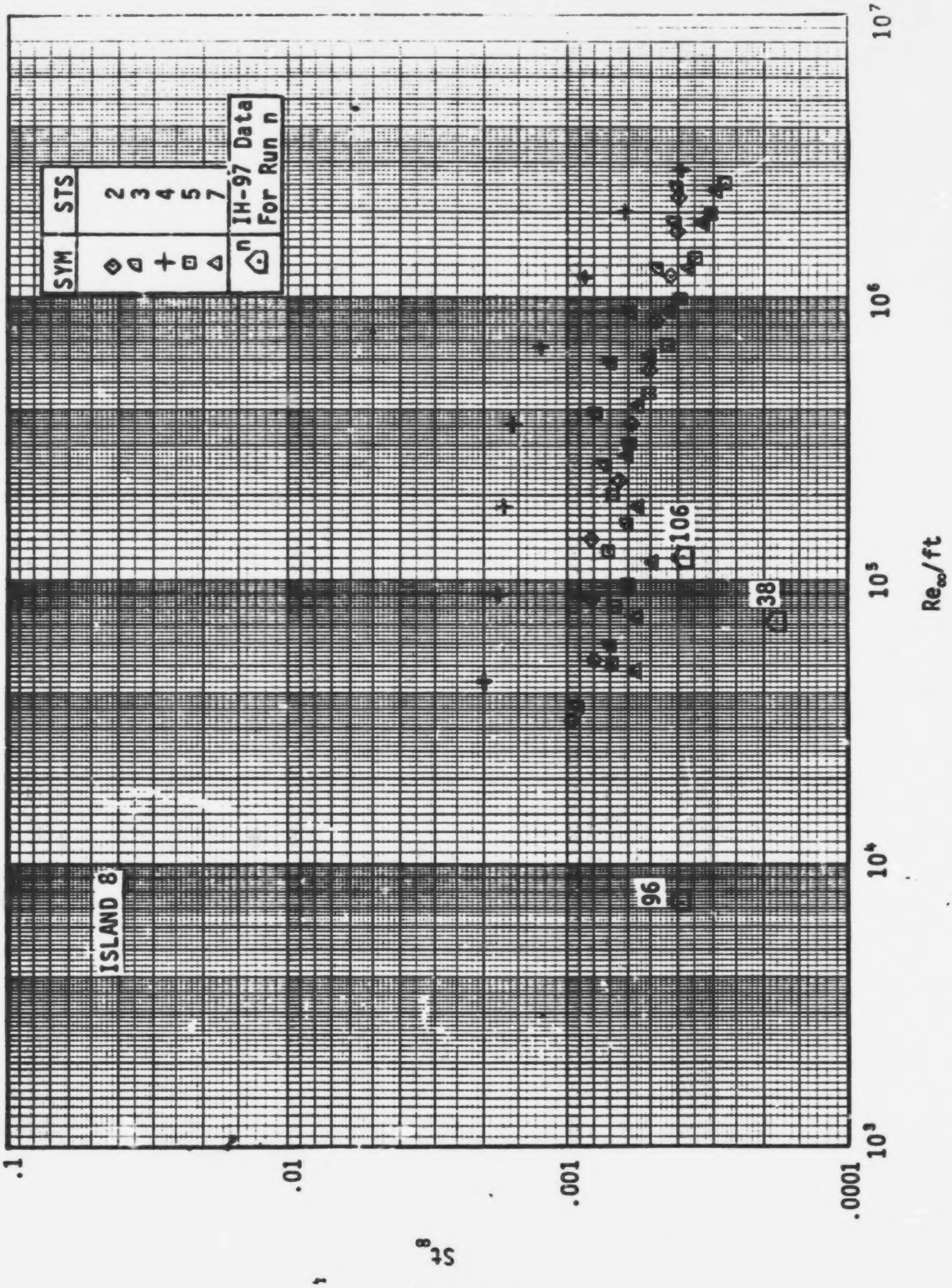

Fig. 6 Stanton Number As A Function Of Reynolds Number For Island 8

C-3

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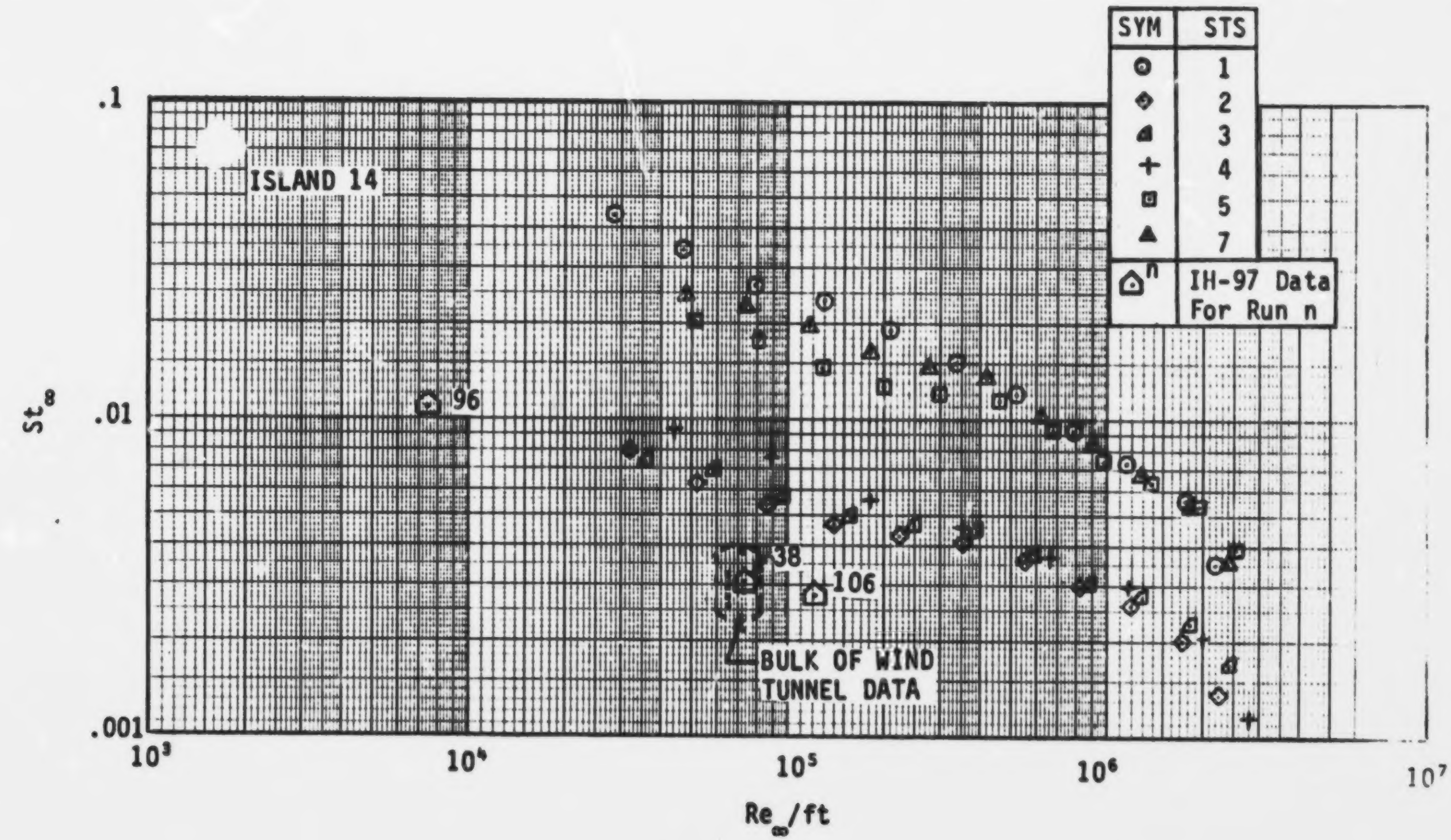

Fig. 7 Stanton Number As A Function Of Reynolds Number For Island 14

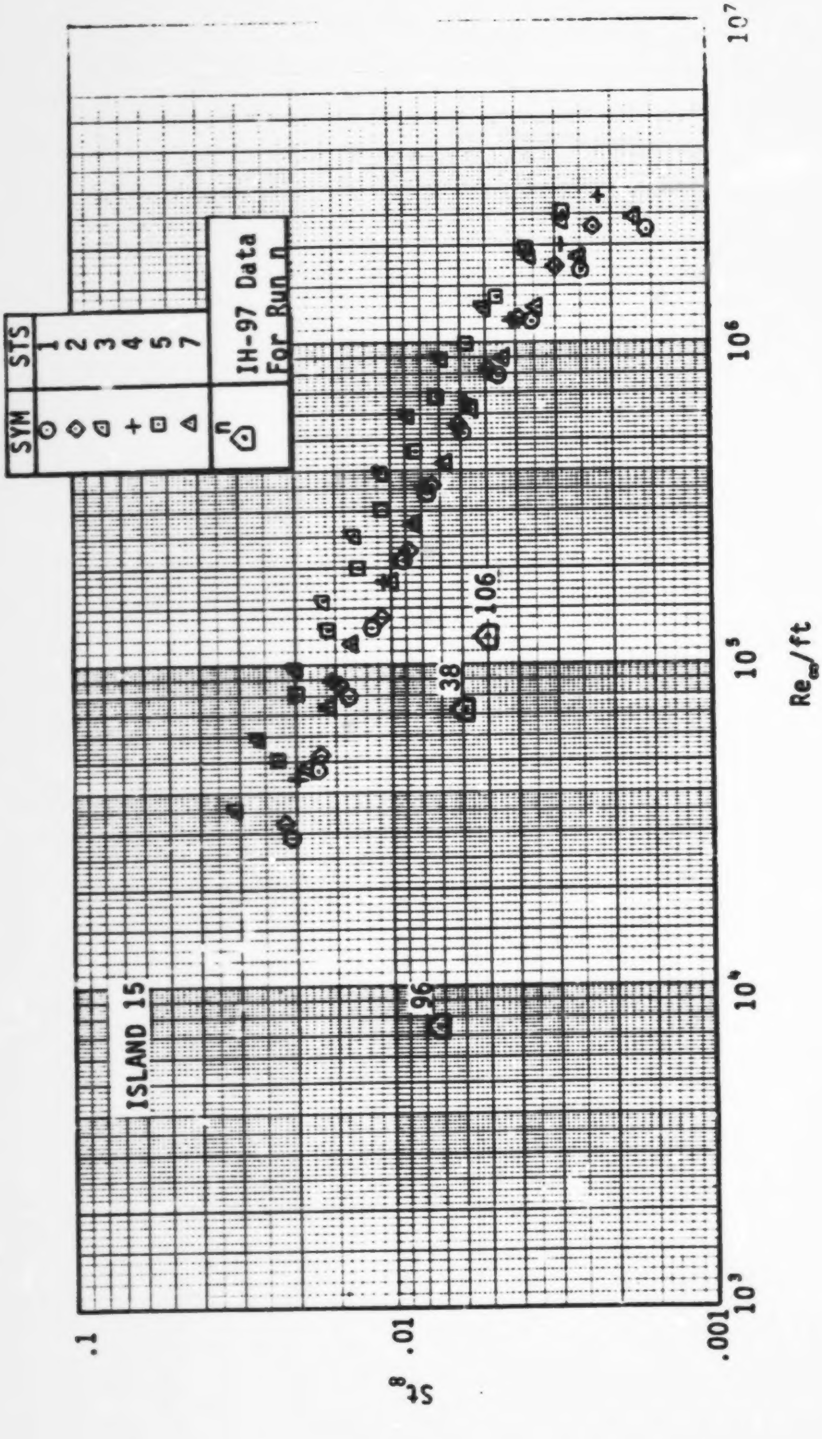

Fig. 8 Stanton Number As A Function Of Reynolds Number For Island 15

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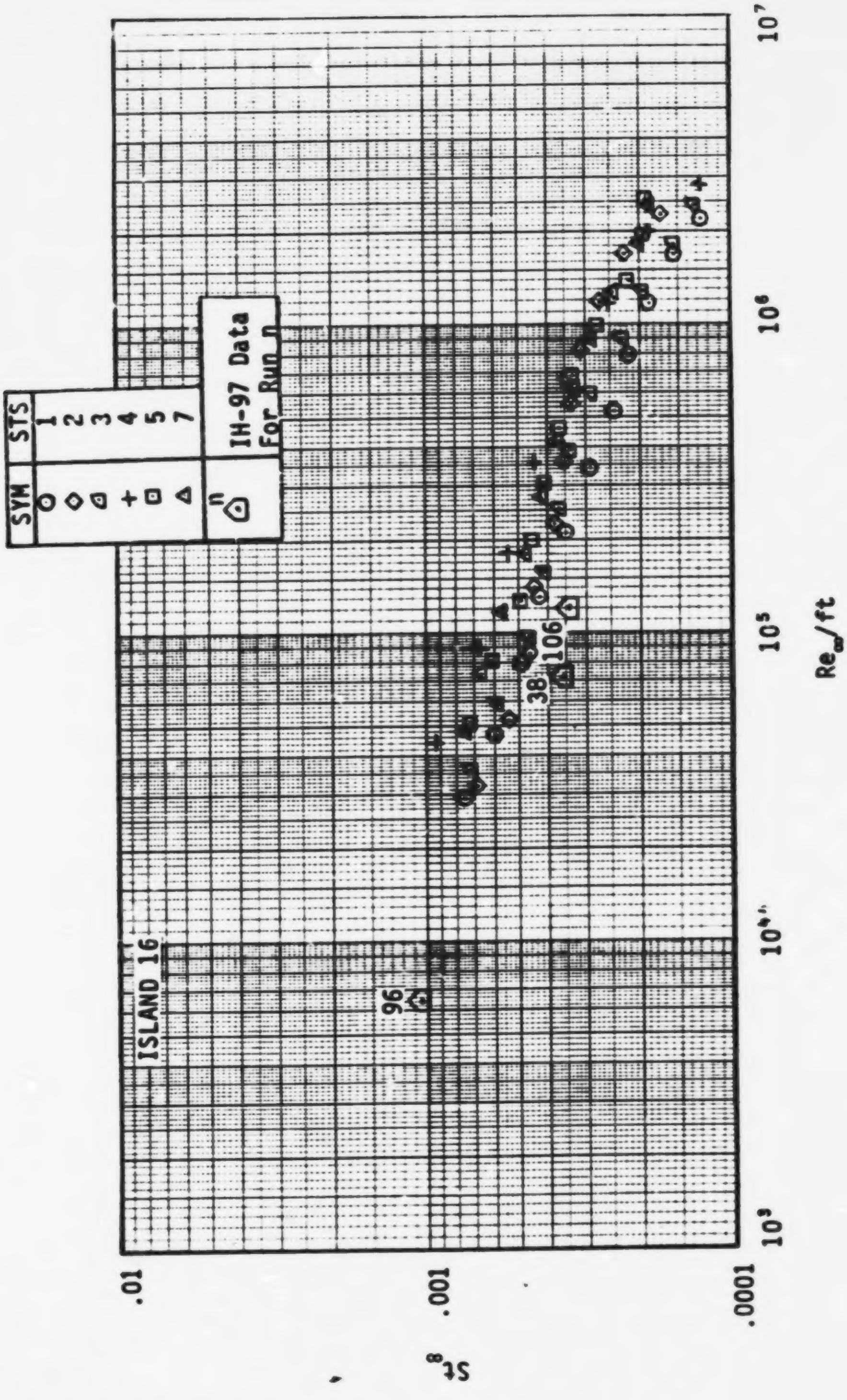

Fig. 9 Stanton Number As A Function Of Reynolds Number For Island 16

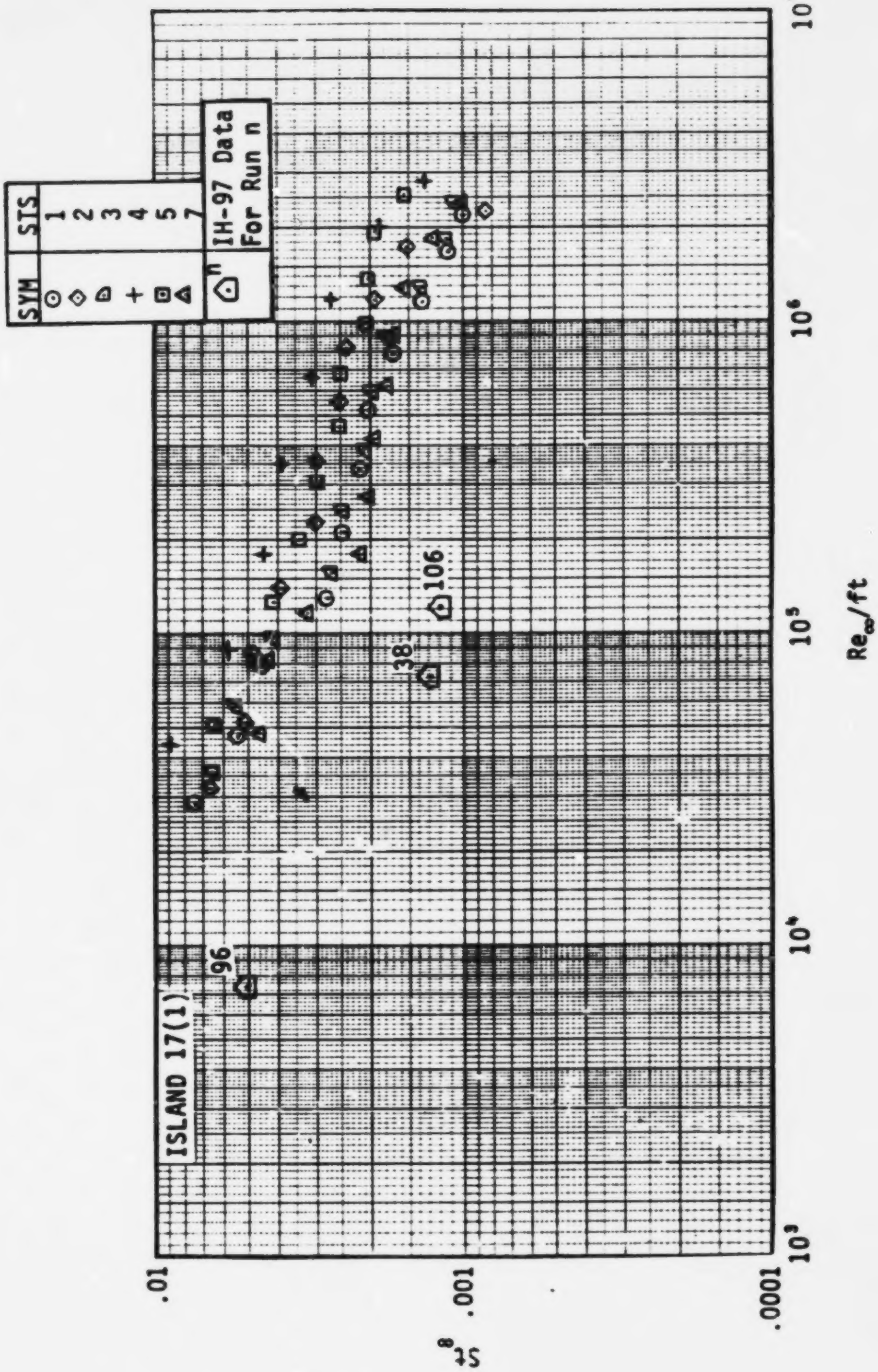

Fig. 10 Stanton Number As A Function Of Reynolds Number For Island 17(1)

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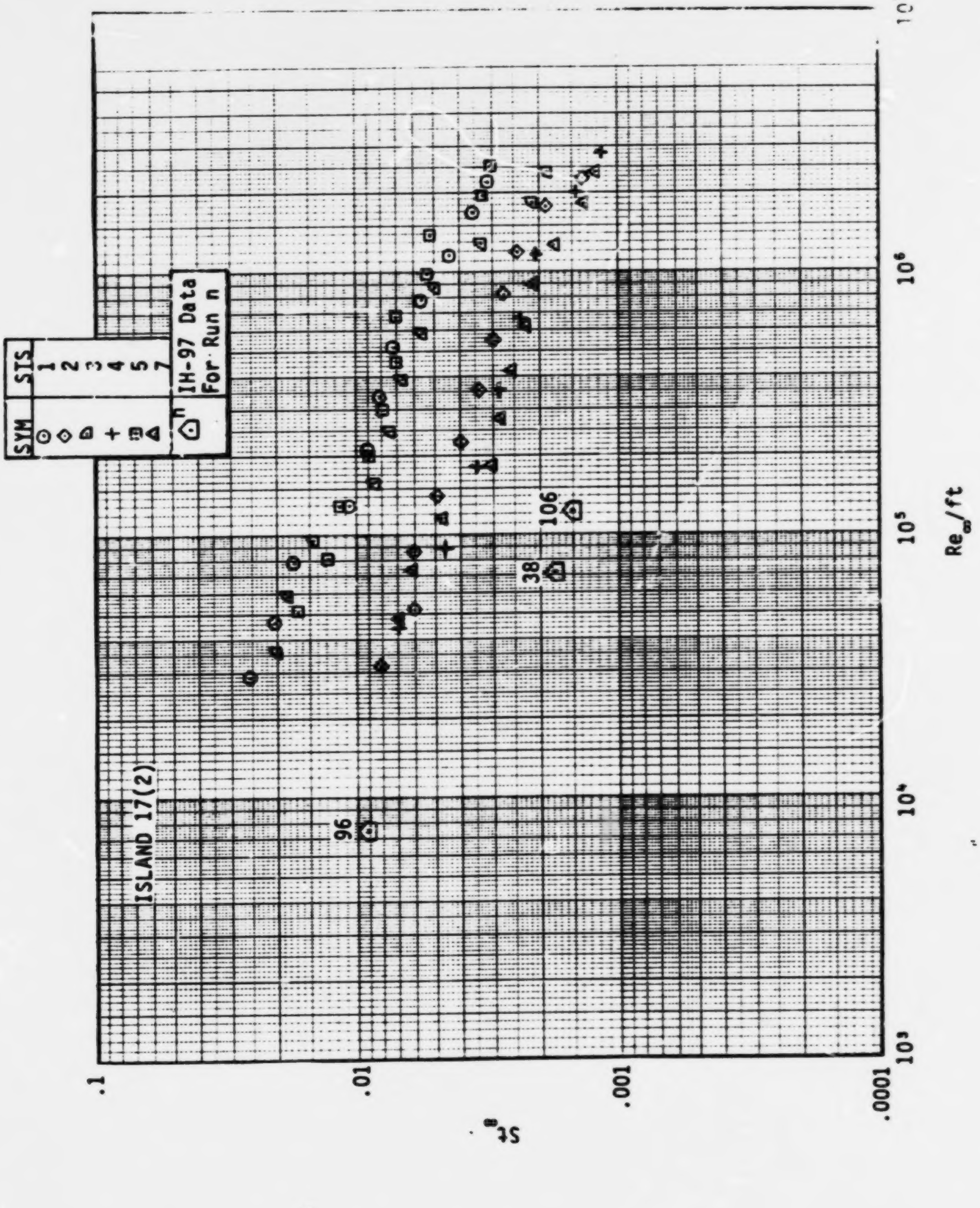

Fig. 11 Stanton Number As A Function Of Reynolds Number For Island 17(2)

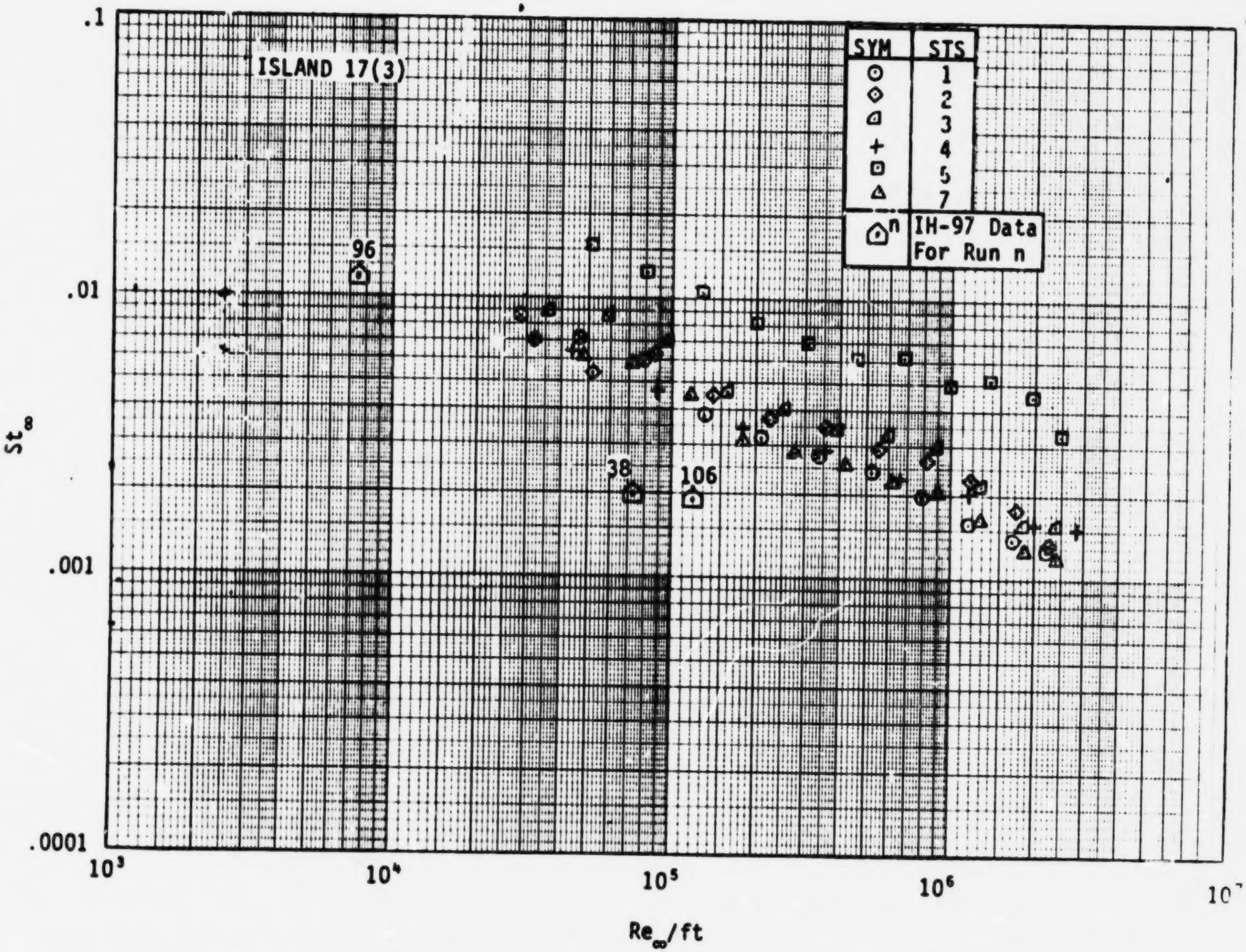

Fig. 12 Stanton Number As A Function Of Reynolds Number For Island 17(3)

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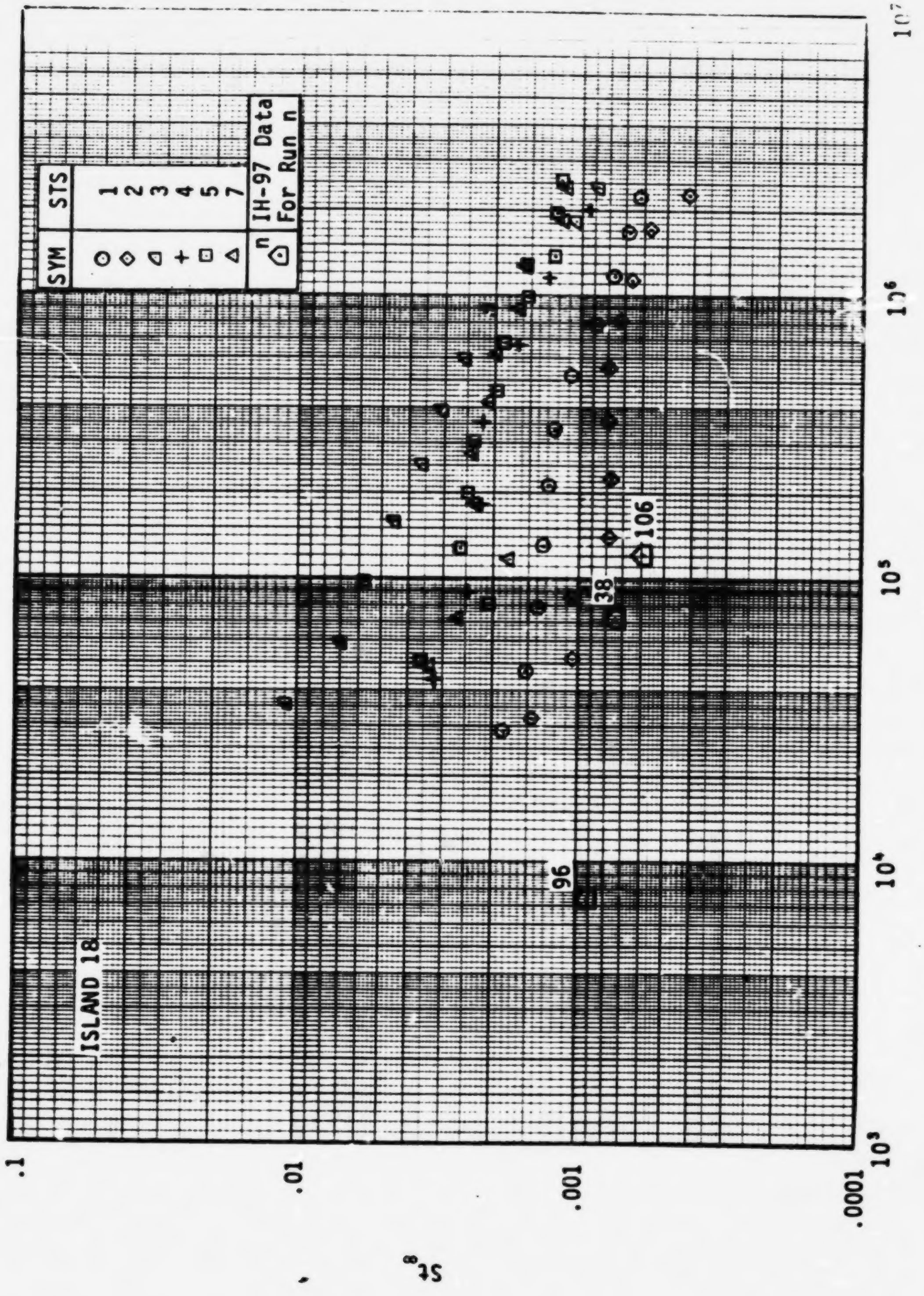

Fig. 13 Stanton Number As A Function Of Reynolds Number For Island 18

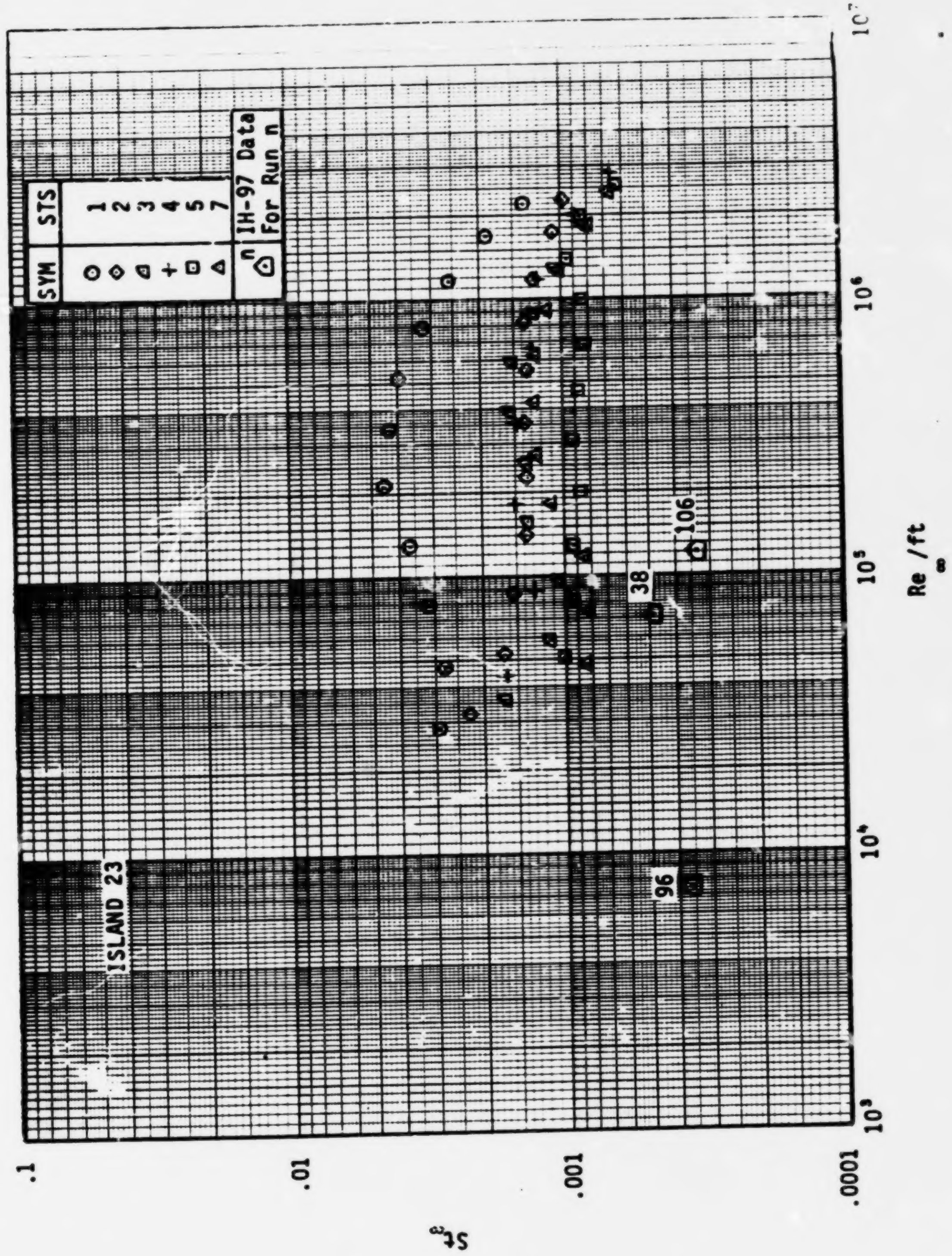

Fig. 14 Stanton Number As A Function Of Reynolds Number For Island 23

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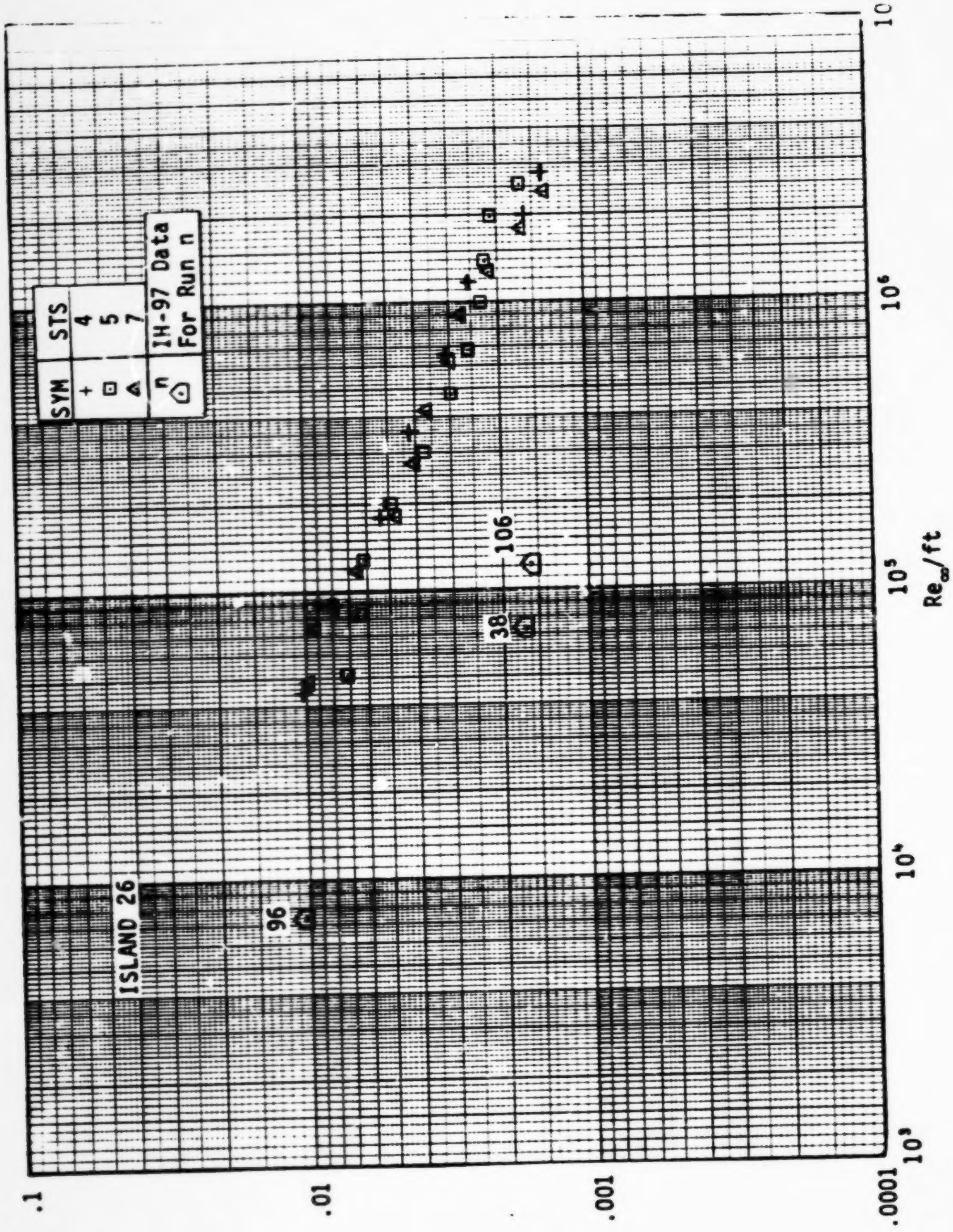

Fig. 15 Stanton Number As A Function Of Reynolds Number For Island 26

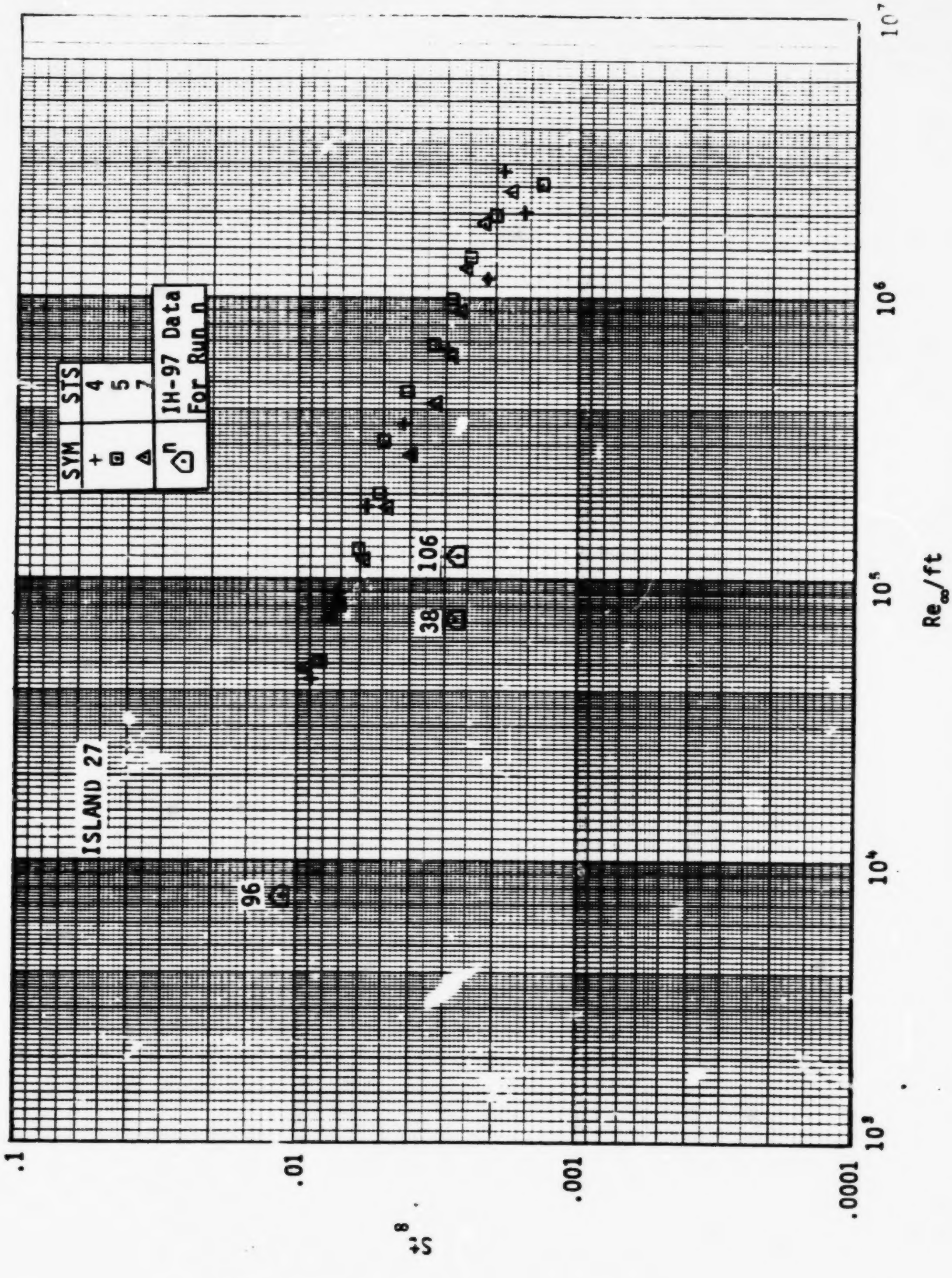

Fig.16 Stanton Number As A Function Of Reynolds Number For Island 27

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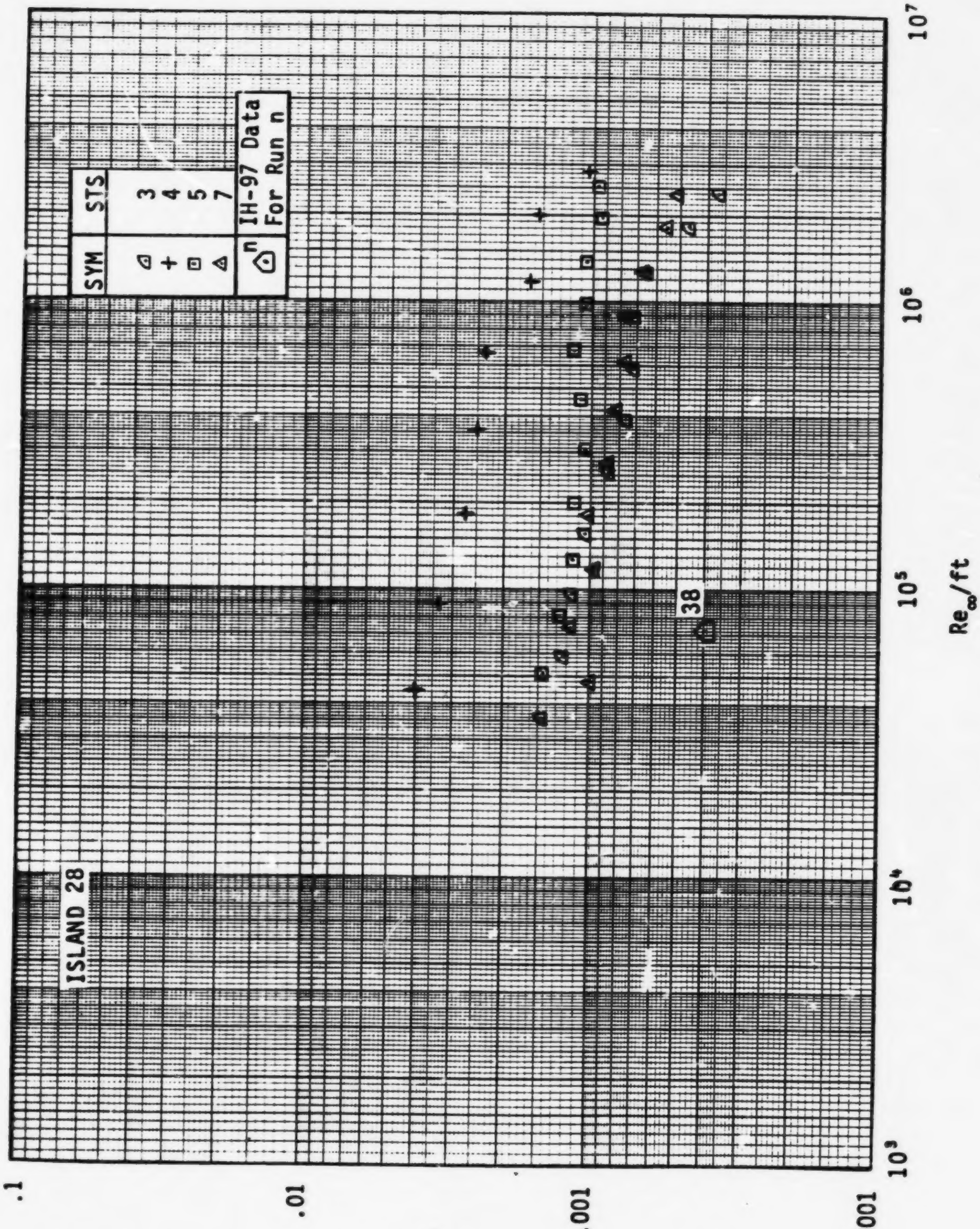

Fig. 17 Stanton Number As A Function Of Reynolds Number For Island 28

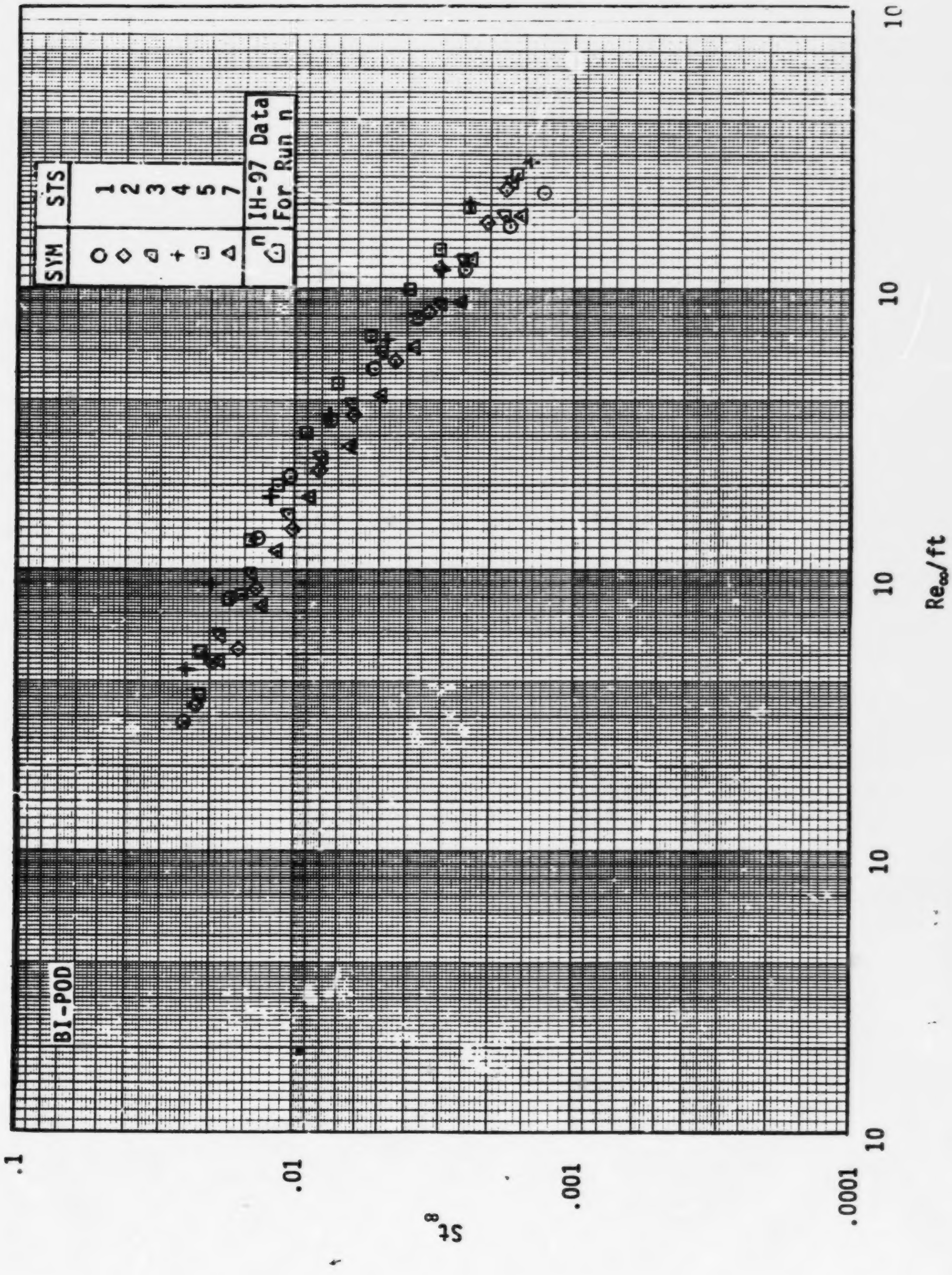

Fig. 18 Stanton Number As A Function Of Reynolds Number For Bi-Pod

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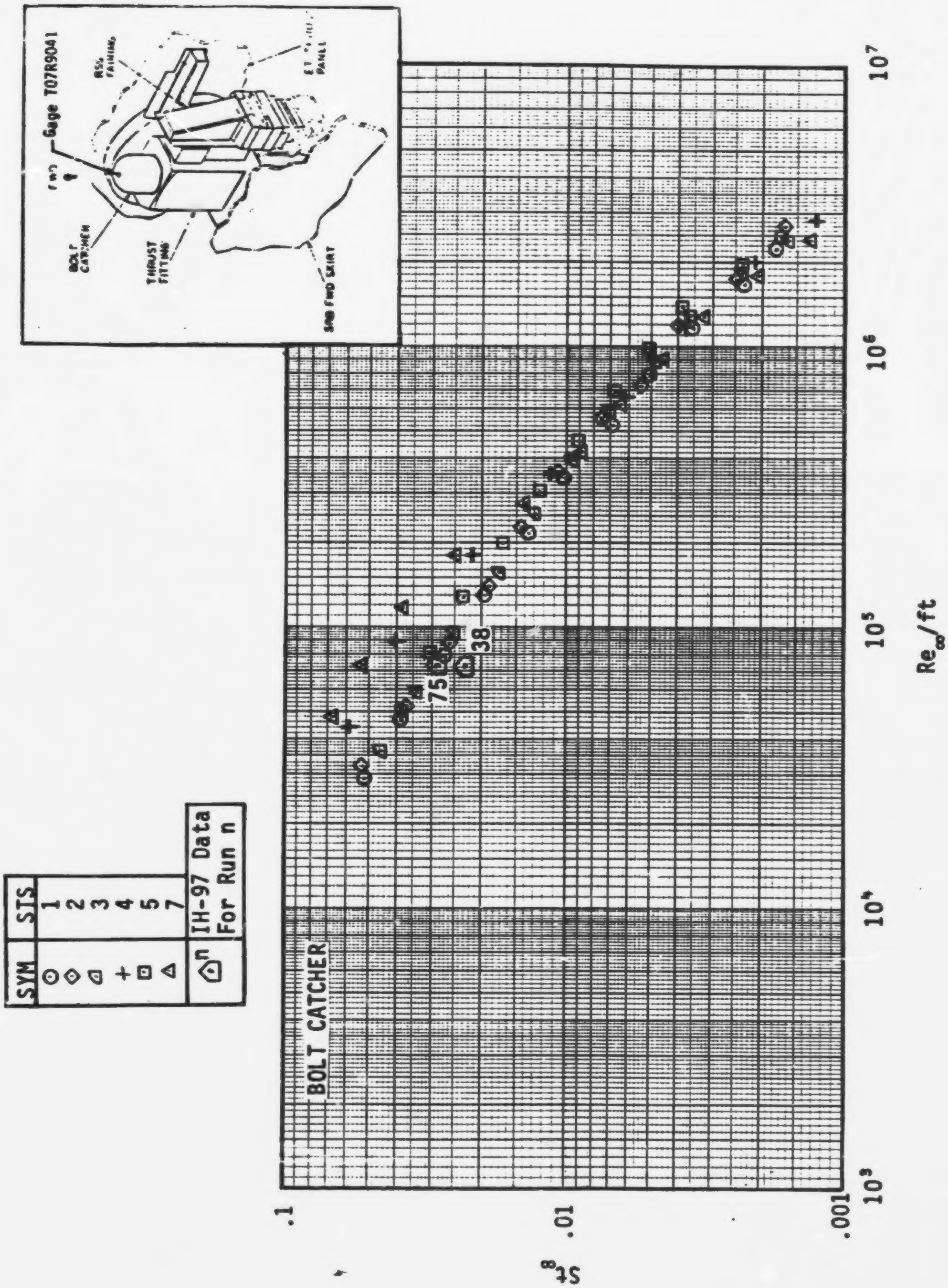

Fig. 19 Stanton Number As A Function Of Reynolds Number For Boltcatcher

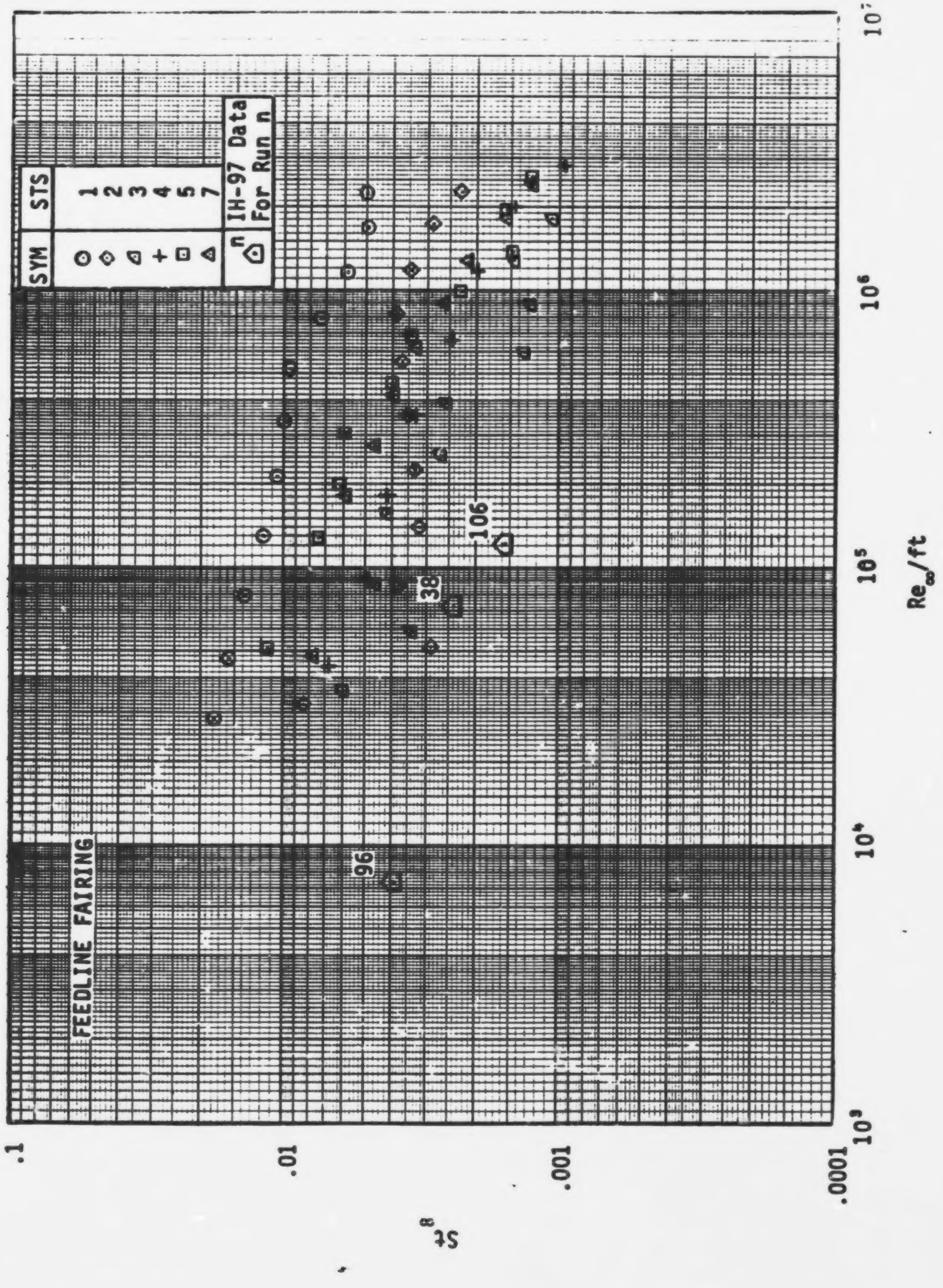

Fig. 20 Stanton Number As A Function Of Reynolds Number For Feedline Fairing

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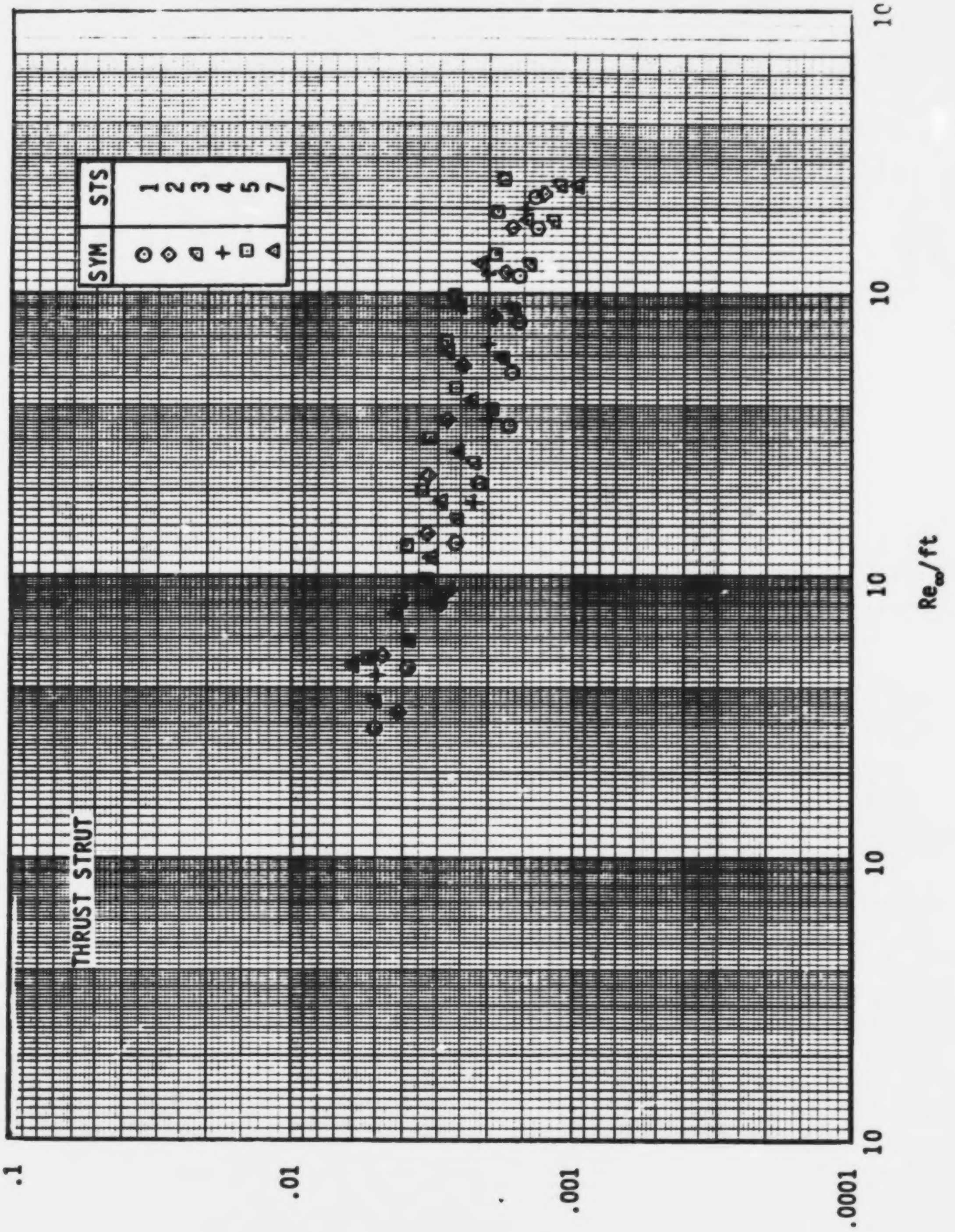

Fig.21 Stanton Number As A Function Of Reynolds Number For Thrust Strut

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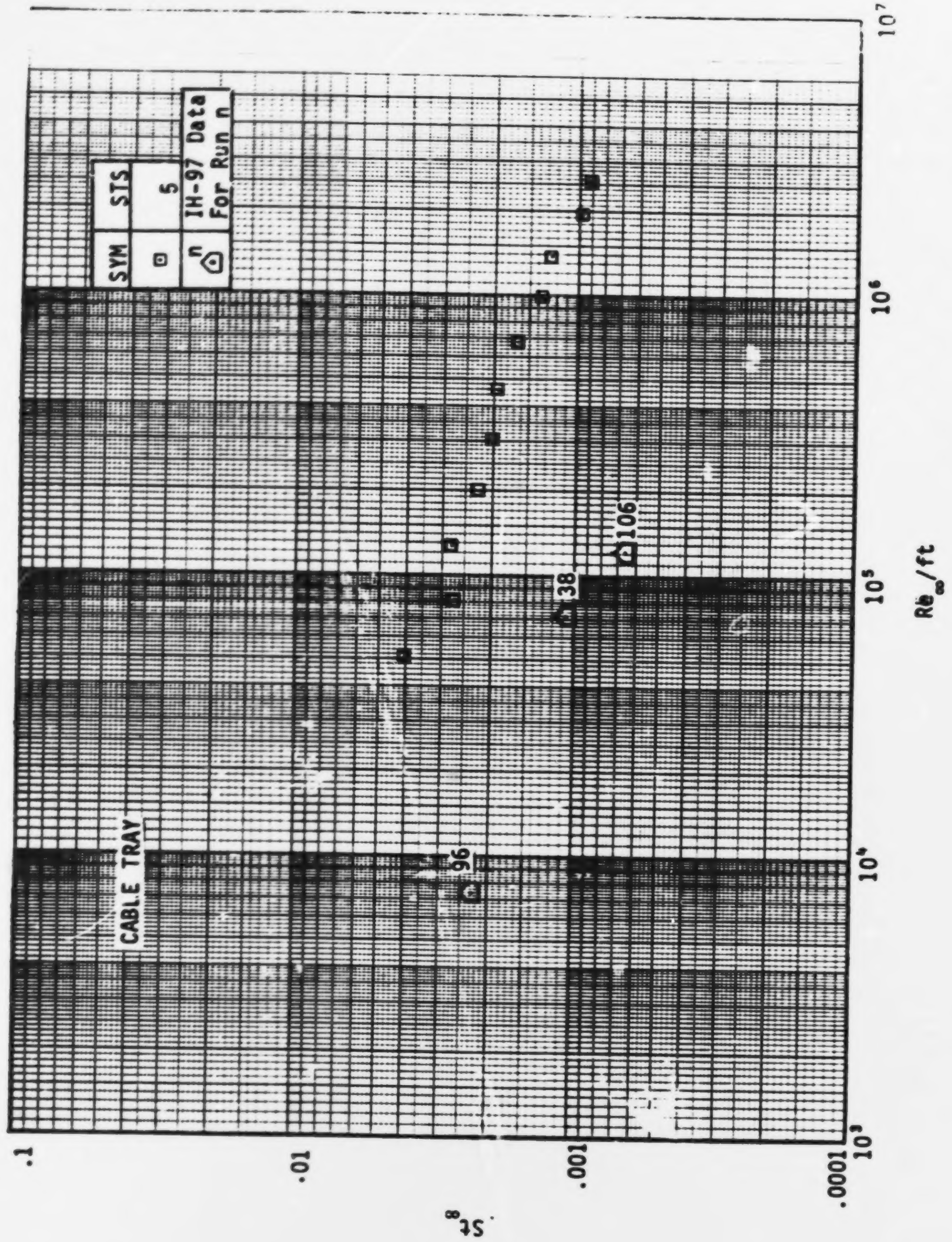

Fig. 22 Stanton Number As A Function Of Reynolds Number For Cable Tray

APPENDIX E

FLIGHT-DERIVED HI/HU TABLES

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-2.00											
-1.00						.7589 0. 1	.7360 1. 2	1.8883 0. 2	1.9815 2. 2		
.00						1.0310 2. 3	.8766 18. 2	1.0652 43. 4			
1.00								1.0224 11. 5			
2.00						.9353 0. 1	.9197 2. 3				
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9001 HT/HO AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					3.5439 0. 1	3.7955 1. 2	2.2905 1. 4				
.00			1.9719 34. 2	2.7607 0. 1	[illegible].6023 9. 3	3.0917 26. 2	2.3996 4. 4				
1.00		1.5858 0. 1	1.9770 28. 3	1.4827 0. 1	1.6941 19. 3	2.3883 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9004 — HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.30						.6399 0. 1	.6141 1. 2				
.00						.7331 3. 3	.6785 10. 2	.6078 2. 3			
1.00								.6701 4. 6			
2.00						.7535 0. 1	.7058 2. 3				
3.00											

GAGE 9001 HT/HU-AT-MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.9676 / 0. 1	.9368 / 1. 3			2.2263 / 1. 4	
.00					1.2970 / 3. 3			.9826 / 2. 4		2.2306 / 0. 1	
1.00									1.4445 / 0. 1	1.5356 / 1. 4	
2.00					1.0604 / 1. 2	1.1458 / 2. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

BAGE 9001 — HT/HU AT-MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.6116 0. 1			2.1031 0. 1		
.00					1.6133 5. 5	1.1306 4. 4	1.0783 0. 3	1.0976 0. 1	2.1203 2. 4		1.9619 3. 3
1.00						1.4106 2. 3				1.7679 0. 1	1.7705 5. 2
2.00						1.3120 1. 2				1.7900 1. 3	
3.00											

BASE 9004 --- HT/MU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.7372 0. 1	.7459 0. 3				
.00					1.0037 2. 3			.7580 1. 4			
1.00									.7734 0. 1	.7944 1. 4	
2.00					.8269 0. 2	.8442 2. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9004 — HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.7422 0. 1					
.00					1.0358 1. 5	.7576 1. 4	.7692 1. 3	.7762 0. 1			.8294 1. 3
1.00						.8970 0. 3				.8047 0. 1	.8465 0. 2
2.00						.8996 0. 2				.8006 1. 3	
3.00											

GAGE 9004 HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					1.0394 0. 1	1.0425 0. 2	.7898 3. 4				
.00			1.0556 0. 2	1.0392 0. 1	1.0316 1. 3	.9358 11. 2	.8144 3. 4				
1.00		1.0440 0. 1	1.0402 1. 3	.8193 0. 1	.8339 1. 3	.8348 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9005 HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.0922 0. 1	.9923 3. 2				
.00						.6110 4. 3	.7659 18. 7	.6165 4. 3			
1.00								.8267 12. 5			
2.00						.6558 0. 1	.6273 2. 3				
3.00											

GAGE 9005 HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.5704 0. 1	1.5277 1. 3				
.00					.7542 1. 3			.8243 3. 4			
1.00									1.0595 0. 1	1.0816 1. 4	
2.00					.7776 0. 2	.8248 2. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9005 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.5316 0. 1					
.00					.8278 1. 5	1.5450 1. 4	.9493 1. 3	.9386 0. 1			1.0732 1. 3
1.00						.7907 2. 3				1.0511 0. 1	1.1045 0. 2
2.00						.8372 0. 2				1.0515 0. 3	
3.00											

PAGE 9005 HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					.8765 0. 1	.8756 0. 2	.9988 2. 4				
.00			.8598 1. 2	.8665 0. 1	.8561 1. 3	.9746 11. 2	1.0158 2. 4				
1.00		.8649 0. 1	.8575 1. 3	1.0687 0. 1	1.0529 0. 3	1.0709 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGE 9007 MI/MU AT MACH 2.50

* ALPHA BETA *	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.9112 0. 1	.8916 0. 2				
.00						.5638 2. 3	.7323 22. 7	.7034 3. 3			
1.00								.7502 2. 5			
2.00						.6576 0. 1	.6360 3. 3				
3.00											

GAGE 9007 — HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.0052 0. 1	1.0374 1. 3				
.00					.6922 2. 3			.7973 0. 4			
1.00									.7805 0. 1	.7477 1. 4	
2.00					.6860 0. 2	.6978 1. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9007 — MT/MU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.8636 0. 1					
.00					.7719 7. 5	.9738 2. 4	.6959 1. 3	.7140 0. 1			.8898 3. 3
1.00						.6785 1. 3				.8367 0. 1	.7169 0. 2
2.00						.6418 1. 2				.8311 1. 1	
3.00											

BASE 9007 HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					.8536 0. 1	.8435 0. 2	.6574 2. 4				
.00			.8867 0. 2	.8673 0. 1	.8367 3. 3	.7745 9. 2	.6761 3. 4				
1.00		.8771 0. 1	.8744 0. 3	.6887 0. 1	.6871 2. 3	.6945 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 900A — HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.6663 0. 1	.6321 2. 2				
.00						.7287 4. 3	.6761 11. 2	.9464 5. 3			
1.00								1.0054 2. 5			
2.00						1.0019 0. 1	1.6877 4. 3				
3.00											

BASE 900A HI/MU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.8596 0. 1	.8652 1. 3				
.00					.9027 0. 3			1.2008 1. 4			
1.00									1.0391 0. 1	1.0448 1. 4	
2.00					2.0297 0. 2	2.0581 0. 3					
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGE 900A — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.8881 0. 1					
.00					.8852 1. 5	.8827 1. 4	1.1590 1. 3	1.1940 0. 1			1.0141 0. 3
1.00						1.9307 0. 3				.9788 0. 1	1.0777 0. 2
2.00						1.9383 1. 2				.9880 0. 1	
3.00											

BASE 900A — HT/HU AT MACH 4.00

DELTA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					.9692 0. 1	.9573 1. 2	1.0637 1. 4				
.00			.9661 0. 2	.9793 0. 1	.9709 4. 3	1.0547 12. 2	1.1031 2. 4				
1.00		.9595 0. 1	.9547 2. 3	1.1932 0. 1	1.1606 1. 3	1.1570 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9010 -- HI/HU-AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.8554 0. 1	.7955 2. 2				
.00						1.3492 5. 3	1.0688 29. 2	.5853 4. 3			
1.00								.6850 7. 5			
2.00						.6132 0. 1	.5653 4. 3				
3.00											

GAGE 9010 — HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.1030 0. 1	1.0849 1. 3				
.00					1.9999 3. 3			.8028 2. 4			
1.00									.8194 0. 1	.8645 2. 4	
2.00					.6917 1. 2	.7552 4. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9010 — MY/MU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.8688 0. 1					
.00					2.4366 1. 5	1.0009 4. 4	.9170 2. 3	.8870 0. 1			1.0226 2. 3
1.00						.9574 2. 3				1.0841 0. 1	.9959 1. 2
2.00						.9058 1. 2				1.1132 1. 3	
3.00											

BASE 9010 HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					2.3856 0. 1	2.4258 1. 2	.6775 3. 4				
.00			2.4252 1. 2	2.2084 0. 1	2.4623 4. 3	1.6126 54. 2	.7287 2. 4				
1.00		2.6018 0. 1	2.5671 2. 3	.7434 0. 1	.7203 1. 3	.7138 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9011 — HI/HU-AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						3.1335 0. 1	2.6228 1. 2	1.3795 0. 2	1.5010 2. 2		
.00						2.1469 3. 3	2.3058 4. 2	2.3017 23. 4			
1.00								1.4542 41. 5			
2.00						2.2855 0. 1	1.9643 8. 3				
3.00											

BAGE 9011 — HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.5548 0. 1	4.2130 2. 3			1.7699 1. 4	
.00					2.8630 2. 3			3.1986 4. 4		1.8859 0. 1	
1.00									1.2229 0. 1	1.2019 4. 4	
2.00					2.8948 1. 2	3.1697 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9011 -- HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						6.6601 0. 1			1.7330 0. 1		
.00					3.3349 6. 5	5.8618 4. 4	3.7340 2. 3	3.5813 0. 1	1.8049 4. 4		1.3576 4. 3
1.00						3.8718 1. 3				1.7291 0. 1	1.7000 4. 2
2.00						3.8032 0. 2				1.2138 8. 3	
3.00											

GAGE 9011 — HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					3.5043 0. 1	3.6585 3. 2	2.9639 16. 4				
.00			3.6935 0. 2	3.5495 0. 1	3.4914 1. 3	3.6208 2. 2	3.0049 15. 4				
1.00		3.5954 0. 1	3.5524 2. 3	4.0485 0. 1	3.9073 7. 3	3.4748 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9012 MI/MU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.3763 0. 1	1.3779 1. 2	2.9152 3. 2	2.9136 1. 2		
.00						1.2905 8. 3	1.3800 4. 2	2.1649 16. 4			
1.00								4.0785 23. 5			
2.00						2.1026 0. 1	1.8425 6. 3				
3.00											

GAGE 9017 HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.9596 0. 1	1.8599 1. 3			2.7497 6. 4	
.00					1.9976 1. 3			3.1067 3. 4		2.6751 0. 1	
1.00									5.6123 0. 1	5.6580 1. 4	
2.00					2.6516 1. 2	2.0703 3. 3					
3.00											

ORIGINAL PAGE
OF POOR QUALITY

GAGE 9017 — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.7938 0. 1			2.5467 0. 1		
.00					2.3701 11. 5	2.3683 7. 4	3.7271 3. 3	3.8680 0. 1	2.5970 7. 4		7.6877 11. 3
1.00						3.0835 3. 3				5.9374 0. 1	9.3390 1. 2
2.00						3.0979 1. 2				5.4638 1. 3	
3.00											

BAGE 9012 HT/HU AT MACH 4.00

DELTA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					3.1449 0. 1	3.2253 0. 2	2.1628 12. 4				
.00			3.1930 7. 2	2.8532 0. 1	3.1105 3. 3	2.6360 22. 2	2.2499 29. 4				
1.00		3.7049 0. 1	3.5913 5. 3	2.1736 0. 1	2.1810 5. 3	2.0409 0. 1					
2.00											
3.00											

ORIGINA
OF POOR

GAGE 9013 — HI/HU AT MACH 2.50

DELTA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.5908 0. 1	3.7858 0. 2	3.0987 1. 2	3.3105 7. 2		
.00						3.6331 4. 3	3.4842 6. 2	2.7609 9. 4			
1.00								3.7041 16. 5			
2.00						8.9904 0. 1	8.4529 6. 3				
3.00											

BAGF 9013 HI/HU AT MACH 3.00

BETA * \ * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						5.8284 0. 1	5.9126 6. 3			4.2050 3. 4	
.00					4.0116 1. 3			3.7408 2. 4		4.3809 0. 1	
1.00									4.8250 0. 1	5.2351 7. 4	
2.00					11.4315 0. 2	10.3503 2. 3					
3.00											

GAGE 9013 — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						6.3582 0. 1			6.0751 0. 1		
.00					6.0257 7. 5	6.2639 3. 6	6.6625 1. 3	6.4979 0. 1	6.2570 16. 4		8.0950 3. 3
1.00						11.5007 1. 3				7.4394 0. 1	8.3624 3. 2
2.00						11.5680 1. 2				6.8118 6. 3	
3.00											

BAGE 9013 HT/HU AT MACH 4.00

BETA \ * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					7.0052 0. 1	6.9833 0. 2	6.7713 6. 4				
.00			7.7508 5. 2	8.9168 0. 1	7.2071 11. 3	7.5653 10. 2	6.9223 16. 4				
1.00		7.4630 0. 1	7.4962 2. 3	8.8372 0. 1	8.5851 4. 3	8.5432 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGF 9014 HI/HU-AT-MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						3.4508 0. 1	3.3443 1. 2	3.3264 1. 2	3.5758 1. 2		
.00						4.1682 3. 3	3.7185 13. 2	3.8954 11. 4			
1.00								4.6676 6. 5			
2.00						3.9170 0. 1	3.5985 5. 3				
3.00											

GAGE 9014 HI/HU-AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						5.0330 0. 1	4.7909 2. 3			4.4031 1. 4	
.00					5.9847 2. 3			5.4007 2. 4		4.7499 0. 1	
1.00									5.4260 0. 1	5.3499 2. 4	
2.00					5.3536 1. 2	5.0130 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9014 — MY/MU-AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						5.7955 0. 1			5.9775 0. 1		
.00					7.4558 3. 5	5.7187 1. 4	6.3012 2. 3	6.1462 0. 1	5.8679 1. 4		6.0496 1. 3
1.00						6.6505 0. 3				5.8877 0. 1	6.2857 1. 2
2.00						6.6410 1. 2				5.8161 1. 3	
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

CASE 9014 — HT/MU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					9.7881 0. 1	9.4530 1. 2	8.2744 2. 4				
.00			11.2490 5. 2	10.3060 0. 1	9.3256 5. 3	9.1197 0. 2	8.4080 5. 4				
1.00		11.4700 0. 1	11.1920 3. 3	9.3300 0. 1	9.5516 1. 3	9.3666 0. 1					
2.00											
3.00											

ORI... PAGE IS
... QUALITY

GAGE 9015 HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						9.7089 0. 1	8.7527 4. 2	6.7832 3. 2	7.5098 2. 2		
.00						6.8017 4. 3	7.6538 8. 2	6.7474 8. 4			
1.00								6.7738 10. 5			
2.00						8.5546 0. 1	7.6778 4. 3				
3.00											

GAGE 9015 — HT/HU-AT-MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						15.1030 0. 1	14.2973 2. 3			11.0515 4. 4	
.00					9.7430 1. 3			8.0015 5. 4		11.9790 0. 1	
1.00									10.5100 0. 1	11.3540 4. 4	
2.00					11.3120 2. 2	12.0103 3. 3					
3.00											

PAGE IS
QUALITY

GAGE 9015 ---- HI/HU-AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						21.9750 0. 1			19.5840 0. 1		
.00					13.6460 5. 5	20.7150 3. 4	19.4600 3. 3	11.6630 0. 1	19.7742 4. 4		18.9770 5. 3
1.00						18.0033 2. 3				16.6890 0. 1	20.6120 2. 2
2.00						16.4750 2. 2				15.5717 3. 3	
3.00											

GAGE 9015 — HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					22.2120 0. 1	21.2520 2. 2	18.3322 4. 4				
.00			25.2215 3. 2	23.8610 0. 1	20.4427 9. 3	21.0500 5. 2	19.4342 8. 4				
1.00		25.0460 0. 1	24.5220 3. 3	23.4940 0. 1	23.4580 2. 3	22.4830 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9014 — MI/MO AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						9.6901 0. 1	9.5319 2. 2	13.4755 1. 2	14.7185 3. 2		
.00						9.7790 5. 3	9.6293 6. 2	11.2830 10. 4			
1.00								5.7912 46. 5			
2.00						11.3390 0. 1	10.7719 3. 3				
3.00											

BARE- 9014 HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						6.4615 0. 1	6.0972 3. 3			20.3235 4. 4	
.00					6.2944 3. 3			14.0635 3. 4		22.3240 0. 1	
1.00									5.9136 0. 1	6.1870 1. 4	
2.00					14.6609 2. 2	14.1347 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9016 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						6.8692 0. 1			28.2500 0. 1		
.00					7.7096 1. 5	6.9178 1. 4	21.9777 1. 3	21.6050 0. 1	28.3370 3. 4		6.8013 2. 3
1.00						19.1583 0. 3				6.5755 0. 1	7.2363 0. 2
2.00						19.0330 0. 2				6.5340 0. 3	
3.00											

BASE 901A — MT/MU AT MACH 9.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					11.1690 0. 1	10.7750 1. 2	26.1502 3. 4				
.00			11.7615 2. 2	11.4730 0. 1	10.2893 7. 3	21.0355 51. 2	20.0087 9. 4				
1.00		11.7050 0. 1	11.7437 1. 3	9.3840 0. 1	31.4757 0. 3	31.7240 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9017 — HI/HH AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.0667 0. 1	1.9961 0. 2	1.9385 1. 2	1.8697 2. 2		
.00						1.5865 4. 3	1.8707 13. 2	1.6277 12. 4			
1.00								1.8806 9. 5			
2.00						2.1293 0. 1	1.9637 7. 3				
3.00											

GAGE 9017 HT/HI AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.9987 0. 1	2.0291 0. 3			1.3218 2. 4	
.00					1.6606 1. 3			1.6765 1. 4		1.2915 0. 1	
1.00									2.2155 0. 1	2.0872 3. 4	
2.00					1.7048 2. 2	1.6274 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9017 — HT/HU-A, MACH -3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.7518 0. 1			1.3061 0. 1		
.00					1.4880 4. 5	1.8137 2. 4	1.1286 4. 3	1.2782 0. 1	1.3144 2. 4		1.1149 3. 3
1.00						1.3029 1. 3				1.1945 0. 1	1.1029 2. 2
2.00						1.2928 0. 2				1.2570 2. 3	
3.00											

GAGE 9017 — HI/HM AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					1.5898 0. 1	1.5237 0. 2	.6337 10. 4				
.00			1.5836 2. 2	1.6914 0. 1	1.5186 4. 3	1.0900 40. 2	.6324 16. 4				
1.00		1.6987 0. 1	1.5611 1. 3	.6745 0. 1	.6541 8. 3	.6975 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 901A — HT/HH AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						7.0143 / 0. 1	5.8892 / 3. 2	8.7208 / 7. 2	9.4532 / 4. 2		
.00						3.8212 / 4. 3	4.5796 / 25. 2	4.2753 / 55. 4			
1.00								3.9339 / 17. 5			
2.00						8.9446 / 0. 1	8.3711 / 6. 3				
3.00											

BASE 901A — HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						10.7360 0. 1	9.9877 6. 3			12.1005 2. 4	
.00					4.1180 1. 3			3.8834 2. 4		12.0280 0. 1	
1.00									4.7195 0. 1	5.1931 7. 4	
2.00					12.9070 1. 2	11.6920 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 901A   HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						12.3470 0. 1			16.8000 0. 1		
.00					4.0933 2. 5	11.9325 2. 4	4.5731 2. 3	4.3326 0. 1	17.5555 19. 4		8.2144 2. 3
1.00						12.8117 0. 3				7.8246 0. 1	8.5899 3. 2
2.00						13.1120 1. 2				6.9912 3. 3	
3.00											

BASE 901A --- HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					7.3413 0. 1	6.8890 1. 2	6.7938 8. 4				
.00			8.0926 5. 2	9.0076 0. 1	7.1937 12. 3	7.7854 13. 2	7.0826 18. 4				
1.00		7.7376 0. 1	7.8825 2. 3	9.5400 0. 1	9.3881 1. 3	9.0799 0. 1					
2.00											
3.00											

GAGF 9019 HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.7701 0. 1	2.4374 2. 2	2.6037 3. 2	2.7479 1. 2		
.00						4.9322 4. 3	3.5150 33. 2	2.5597 5. 4			
1.00								3.3082 11. 5			
2.00						3.6914 0. 1	3.3409 5. 3				
3.00											

GAGE 9019 HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						3.6088 0. 1	3.3755 3. 3			1.2930 2. 4	
.00					5.4304 1. 3			2.9982 1. 4		1.2958 0. 1	
1.00									4.0360 0. 1	4.4005 7. 4	
2.00					4.9984 3. 2	4.1947 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9019 — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.0145 0. 1			4.2997 0. 1		
.00					6.5944 1. 5	3.7787 3. 4	3.3651 1. 3	3.3133 0. 1	4.6194 17. 4		6.8861 3. 3
1.00						4.8539 3. 3				5.8074 0. 1	7.0886 3. 2
2.00						4.9196 1. 2				5.5501 1. 3	
3.00											

GAGE 9019 HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					9.3519 0. 1	8.4800 2. 2	4.6805 7. 4				
.00			10.5035 3. 2	11.1080 0. 1	9.1261 11. 3	7.3094 17. 2	4.7137 15. 4				
1.00		9.8489 0. 1	10.0856 2. 3	6.2607 0. 1	6.2354 1. 3	6.3195 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9021 - HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.0796 0. 3	1.0341 3. 2	.8766 0. 2	.8354 6. 2		
.00						.8837 6. 3	.9351 2. 2	1.1526 8. 4			
1.00								1.2459 6. 6			
2.00						2.2192 0. 1	2.0805 3. 1				
3.00											

GAGE 9021 —— HT/H0 AT MACH 3.00

* ALPHA / BETA *	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.7801 0. 1	.7723 11. 3			.6886 1. 4	
.00					.6702 7. 3			.6809 1. 4		.6509 0. 1	
1.00									.2944 0. 1	.3240 6. 4	
2.00					.7772 7. 2	.8086 4. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9021 — HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.9258 0. 1			.7480 0. 1		
.00					1.0569 6. 5	.8971 2. 4	.7479 3. 3	.7095 0. 1	.8084 3. 4		.7647 5. 3
1.00						.9390 2. 3				.6871 0. 1	.8666 1. 2
2.00						.9136 1. 2				.6236 4. 3	
3.00											

GAGE 9021 HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					1.1764 0. 1	1.1305 1. 2	1.1557 4. 4				
.00			1.1782 11. 2	1.2330 0. 1	1.2002 3. 3	1.1873 1. 2	1.1353 6. 4				
1.00		1.0957 0. 1	1.1415 8. 3	.9708 0. 1	1.0544 7. 3	1.2365 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

```
GAGE 9022 — HT/HO AT MACH 2.50
     * ALPHA  -4.CO   -3.0C   -2.00   -1.00    .00    1.00    2.00    3.00    4.00    5.00    6.00
 BETA *
**************************************************************************************************
   -3.00

   -2.00

   -1.00                                     1.8637  1.7121
                                             0.   1  2.   2
    .00                                      1.8996  1.8110  1.9213
                                             4.   3  7.   2  4.   3
   1.00
                                                             1.8808
                                                             8.   5
   2.00                                      1.9256  1.9238
                                             0.   1  2.   1
   3.00
**************************************************************************************************
```

BAGE 9022 HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.3939 0. 1	2.3288 1. 3				
.00					2.2075 2. 3			1.8498 2. 4			
1.00									1.8007 0. 1	1.7806 2. 4	
2.00					1.3925 1. 2	1.3939 1. 3					
3.00											

OF POOR QUALITY

GAGE 9022 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						1.6510 0. 1					
1.00					2.4335 2. 5	1.8796 5. 4	1.8367 0. 3	1.6660 0. 1			1.5979 1. 3
2.00						1.3744 1. 3				1.5308 0. 1	1.6185 G. 2
3.00						1.4746 0. 2				1.5179 1. 3	

BAGE—9022 —— HI/MU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					1.7882 0. 1	1.9042 1. 2	1.1759 12. 4				
.00			2.0527 5. 2	1.8311 0. 1	1.9591 8. 3	1.4920 30. 2	1.0717 17. 4				
1.00		2.1765 0. 1	2.1189 3. 3	1.1549 0. 1	1.0880 1. 3	1.0242 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9025 — H3/HU AT MACH 2.50

BETA * / * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.1916 0. 1	.1922 0. 2				
.00						1.4192 4. 3	.0511 77. 2	1.0854 2. 3			
1.00								2.0161 0. 1			
2.00						.5464 0. 1	.6304 2. 3				
3.00											

GAGE 9025 — HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.1924 0. 1	.1818 2. 3				
.00					.9670 4. 3			?.1159 2. 4			
1.00											
2.00					.0917 1. 2	.0432 57. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9024 — NI/NU AT MACH 3.50

BETA * / * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.0755 0. 1					
.00					1.2826 1. 5	.1353 4. 4	1.9330 4. 3	2.0333 0. 1			
1.00											
2.00											
3.00											

BAGE 9025 HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					1.4646 0. 1	1.3980 0. 2	1.3827 3. 4				
.00			1.5445 10. 2	1.3456 0. 1	1.3169 12. 3	1.3425 4. 2	1.4979 8. 4				
1.00		1.8071 0. -1	1.6821 5. 3	1.0320 0. 1	1.2939 5. 3	1.2224 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9026 MI/MU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.1278 0. 1	1.0807 1. 2				
.00						3.4740 3. 3	2.2411 57. 2	1.0249 3. 3			
1.00								1.0924 0. 1			
2.00						1.7095 0. 1	1.7666 2. 3				
3.00											

GAGE 9026 HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.2256 0. 1	1.1851 1. 3				
.00					4.1337 1. 3			1.1934 1. 4			
1.00											
2.00					2.0346 0. 2	1.0965 3. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9026 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						1.4453 0. 1					
.00					4.3745 1. 5	1.3644 4. 4	1.3186 1. 3	1.3011 0. 1			
1.00						1.7111 1. 3					
2.00						1.7278 2. 2					
3.00											

BAGE 9026 HI/HU AT MACH 4.00

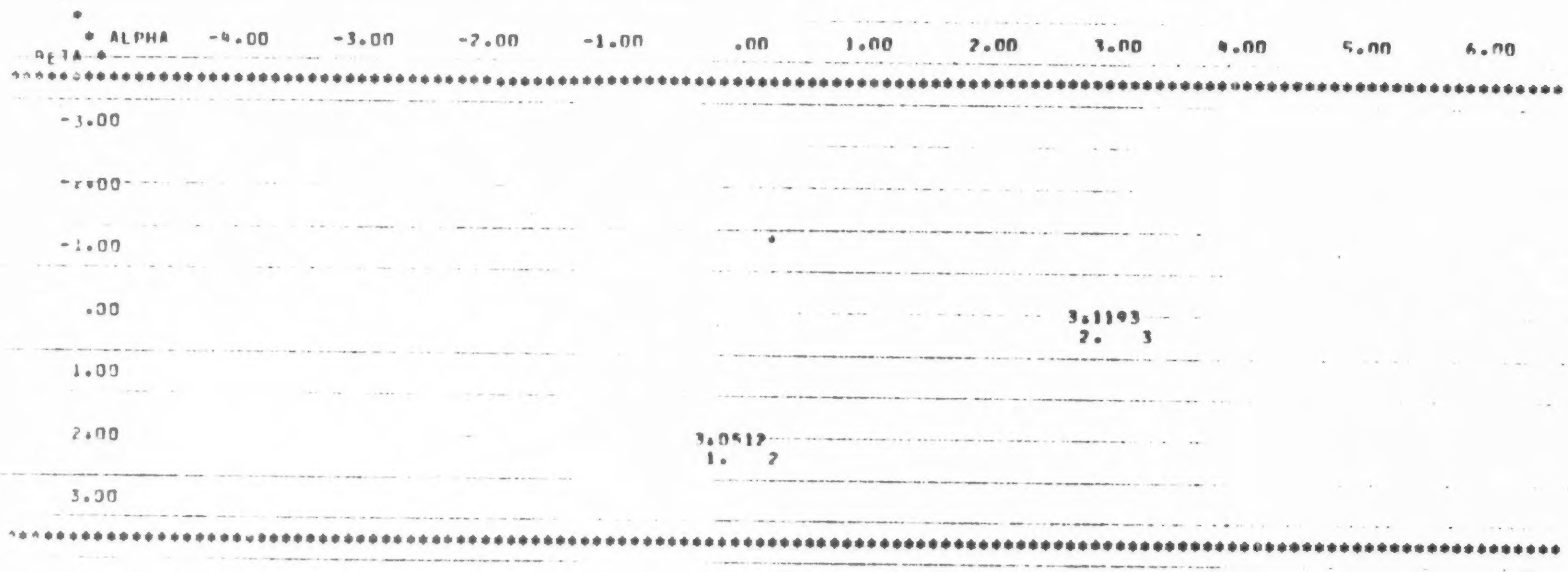
BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					5.2518 0. 1	5.1598 0. 2	1.4396 3. 4				
.00			5.5401 1. 2	5.3529 0. 1	4.9744 4. 3	3.3291 50. 2	1.4813 4. 4				
1.00		5.9015 0. 1	5.5007 3. 3	1.6119 0. 1	1.5326 5. 3	1.5808 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9027 HI/MU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.3569 0. 1	.4159 0. 2				
.00						2.4290 7. 3	1.4479 64. 2	2.0008 5. 3			
1.00								1.6916 15. 5			
2.00						2.2093 0. 1	1.9823 5. 3				
3.00											

GAGE 9027 HT/H0 AT MACH 3.00



ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9027 — HI/HH AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00											
1.00											
2.00											
3.00											

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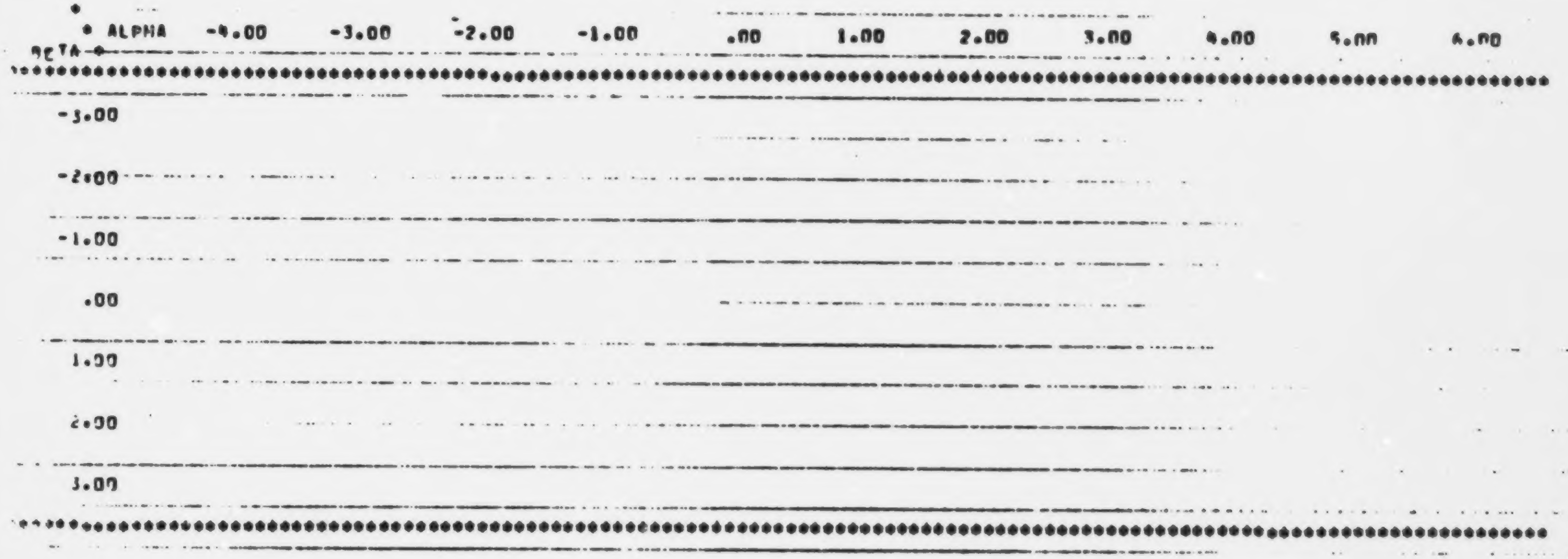
OF POOR QUALITY

BAGE 9027 HI/HU-AT-MACH 4.00



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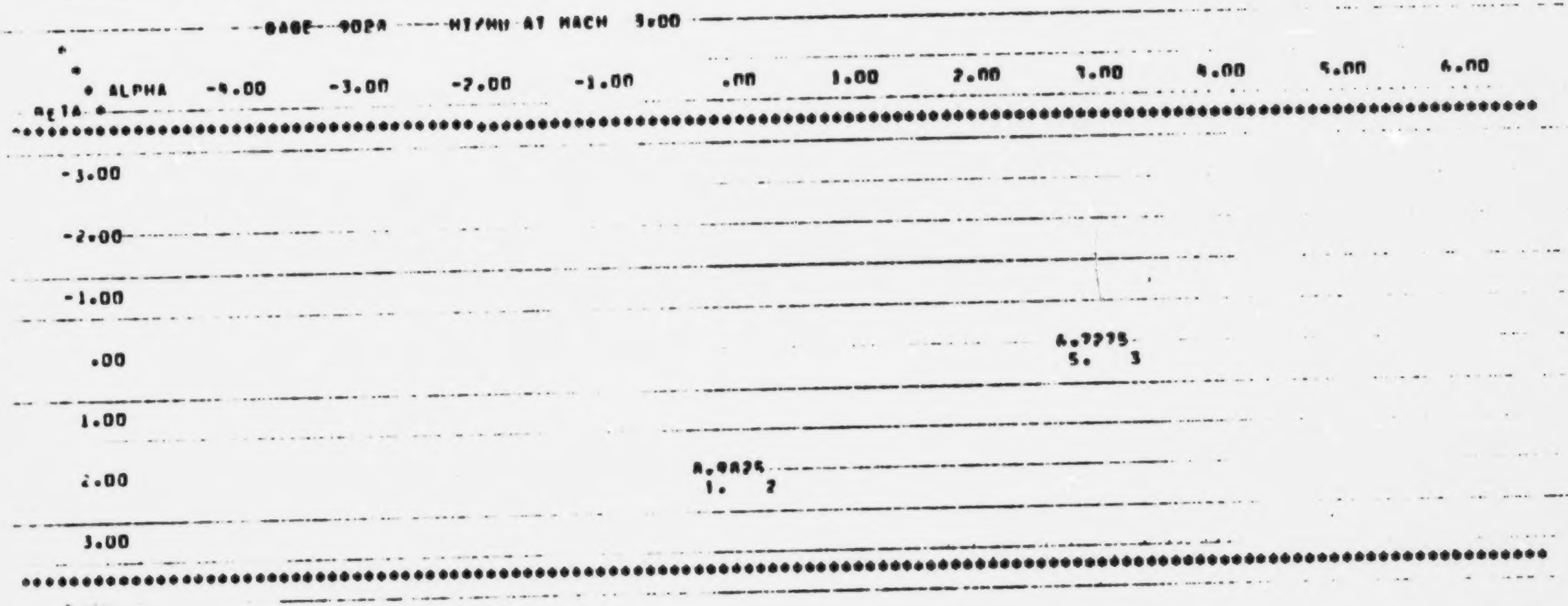
GAGE 9D2A — HT/HU-AT MACH 2.50

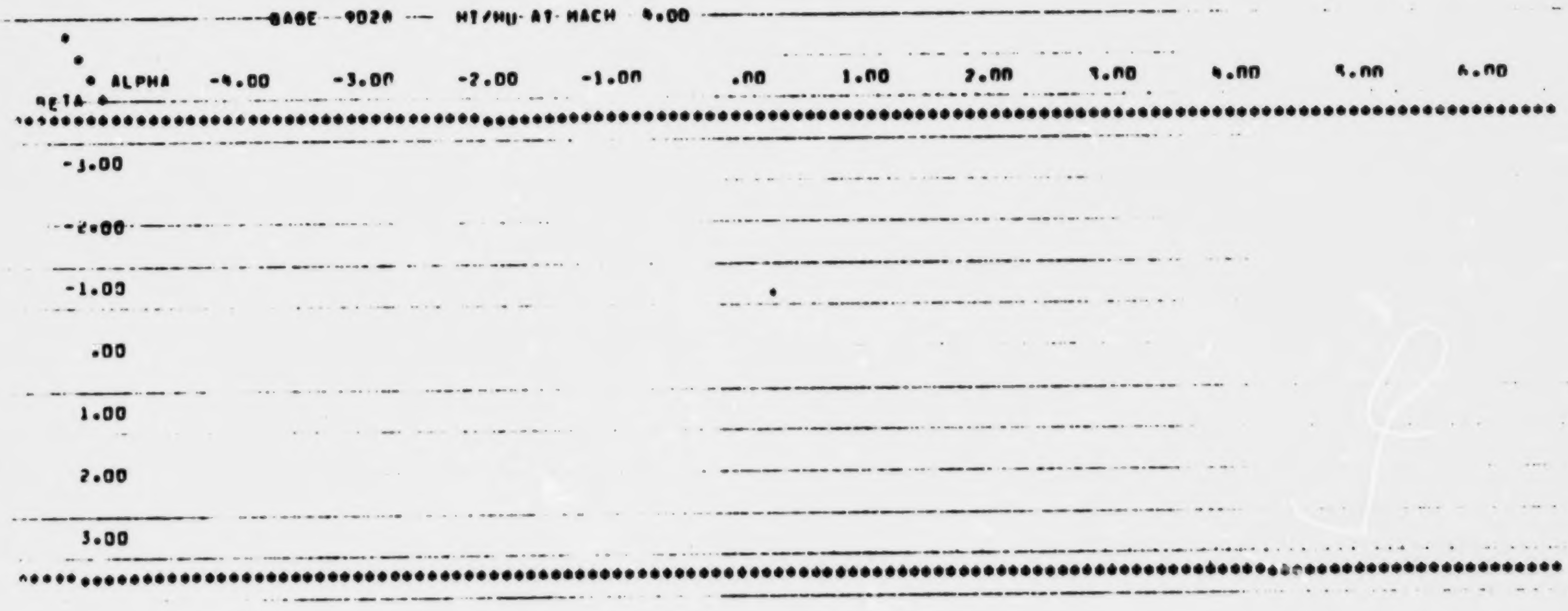
BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						2.1876 2. 3	8.1862 0. 1	4.5875 6. 3			
1.00								5.5373 8. 5			
2.00						8.7611 0. 1	7.5975 9. 3				
3.00											



ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 902A -- HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00											
1.00											
2.00											
3.00											



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OF POOR QUALITY

GAGE 9029 MI/MU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						1.1563 3. 3	1.1909 0. 1	1.0199 2. 3			
1.00								1.1702 12. 5			
2.00						1.1702 0. 1	1.1175 3. 3				
3.00											

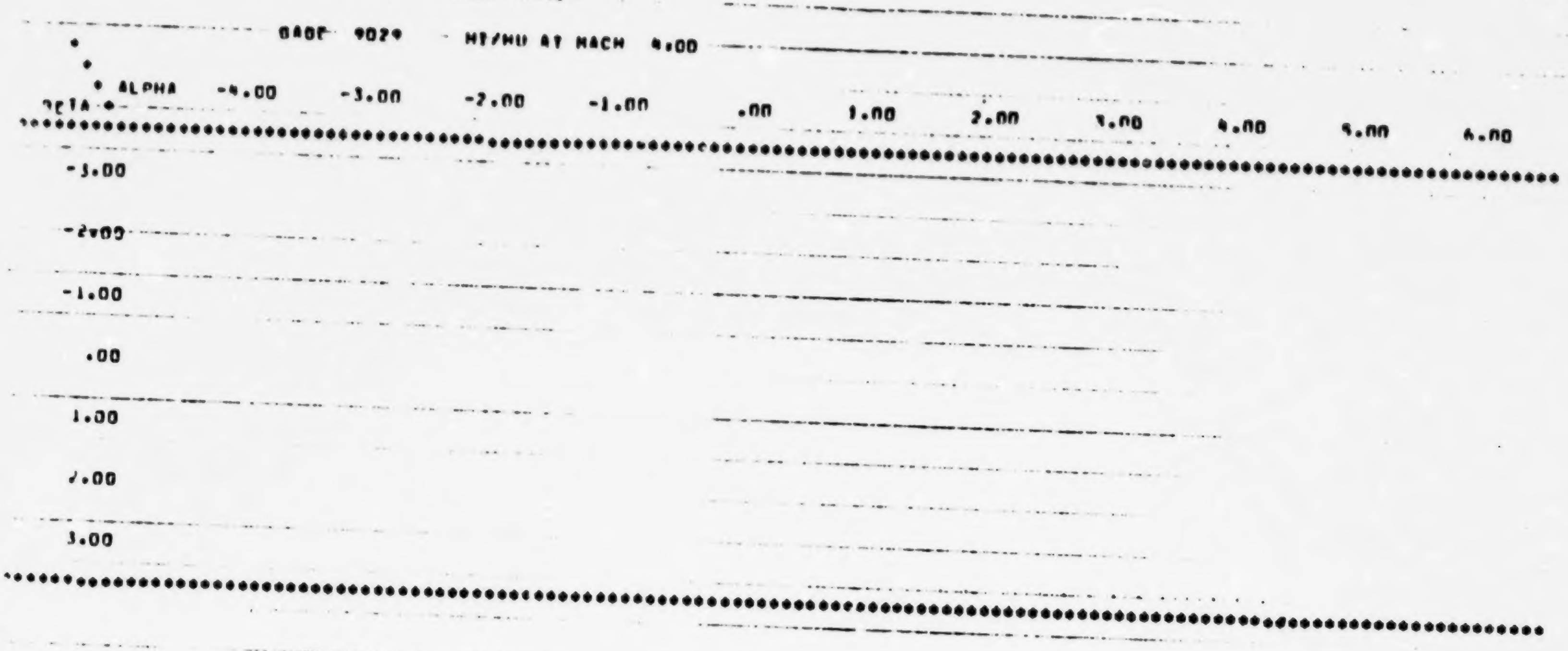
0ADE 9029 MIYMU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00					1.4592 0. 3			1.9492 2. 4			
1.00									.9882 0. 1	.8728 8. 2	
2.00					1.2103 2. 2	1.1874 2. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9029 HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00											
1.00											
2.00											
3.00											



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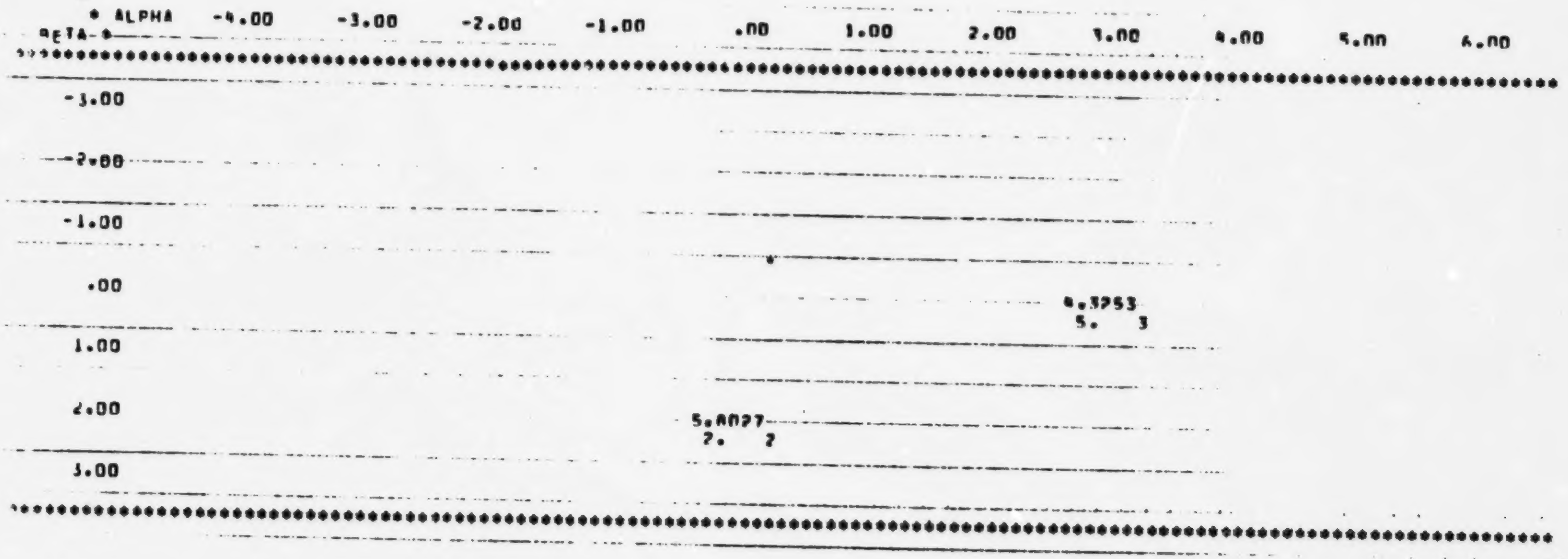
OF POOR QUALITY

GAGE 903A — MT/MU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						.2107 0. 1	.1818 0. 2				
.00						3.9006 0. 3	2.0151 95. 2	2.6440 11. 3			
1.00								2.7077 4. 5			
2.00						4.1270 0. 1	3.4232 10. 3				
3.00											

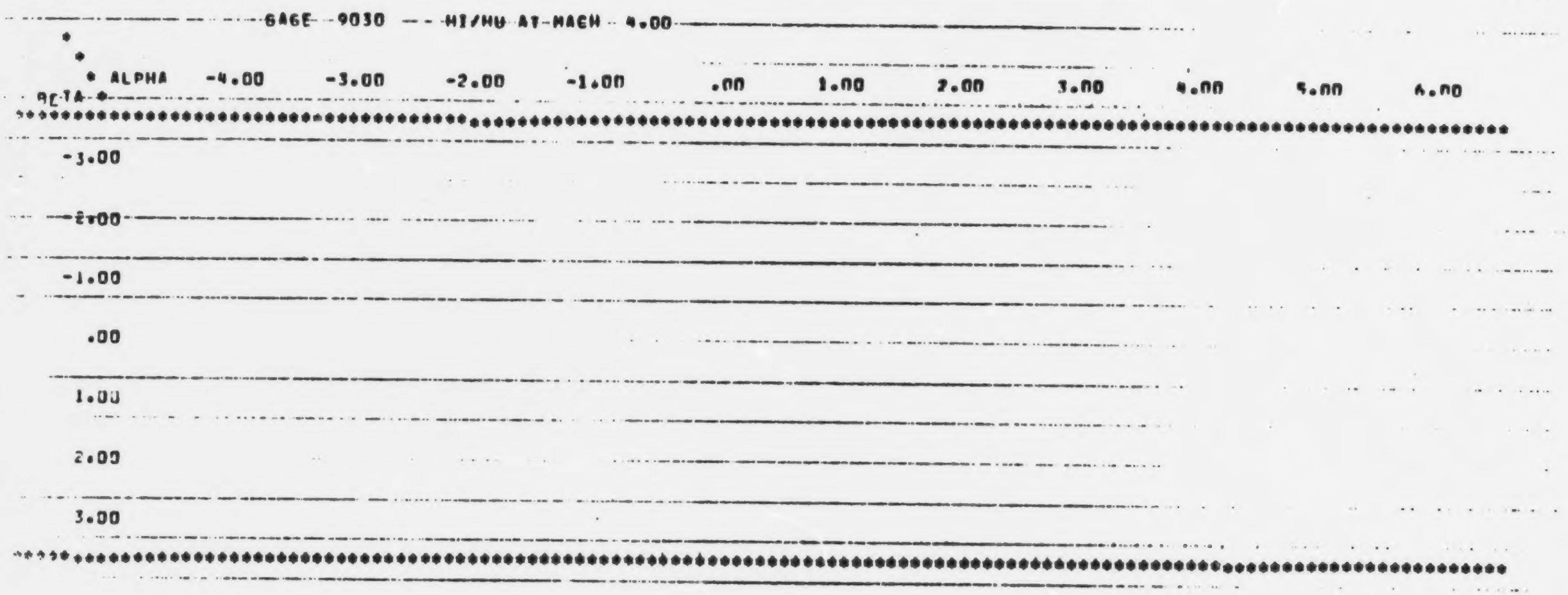
BASE 9030 — HT/HU AT MACH 3.00



ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9838 HI/HU AT MACH 3.50

BETA * / * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00											
1.00											
2.00											
3.00											



ORIGINAL [illegible]
OF POOR QUALITY

GAGE 9031 HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						.8561 0. 1	.7801 7. 2				
1.00						4.2108 2. 3	2.4190 80. 2	3.0688 5. 3			
2.00								1.6414 92. 2			
3.00						4.8984 0. 1	4.3219 10. 3				

GAGE 9031 --- HT/HU AT MACH 3.00

```
* ALPHA   -4.00   -3.00   -2.00   -1.00    .00    1.00    2.00    3.00    4.00    5.00    6.00
BETA
-3.00
-2.00
-1.00
  .00                                                        4.5997
                                                             3.   3
 1.00
 2.00                                      7.5363
                                           5.   2
 3.00
```

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE -9031 MI/MU AT MACH 3.50

ALPHA -4.00 -3.00 -2.00 -1.00 .00 1.00 2.00 3.00 4.00 5.00 6.00

BETA

-3.00

-2.00

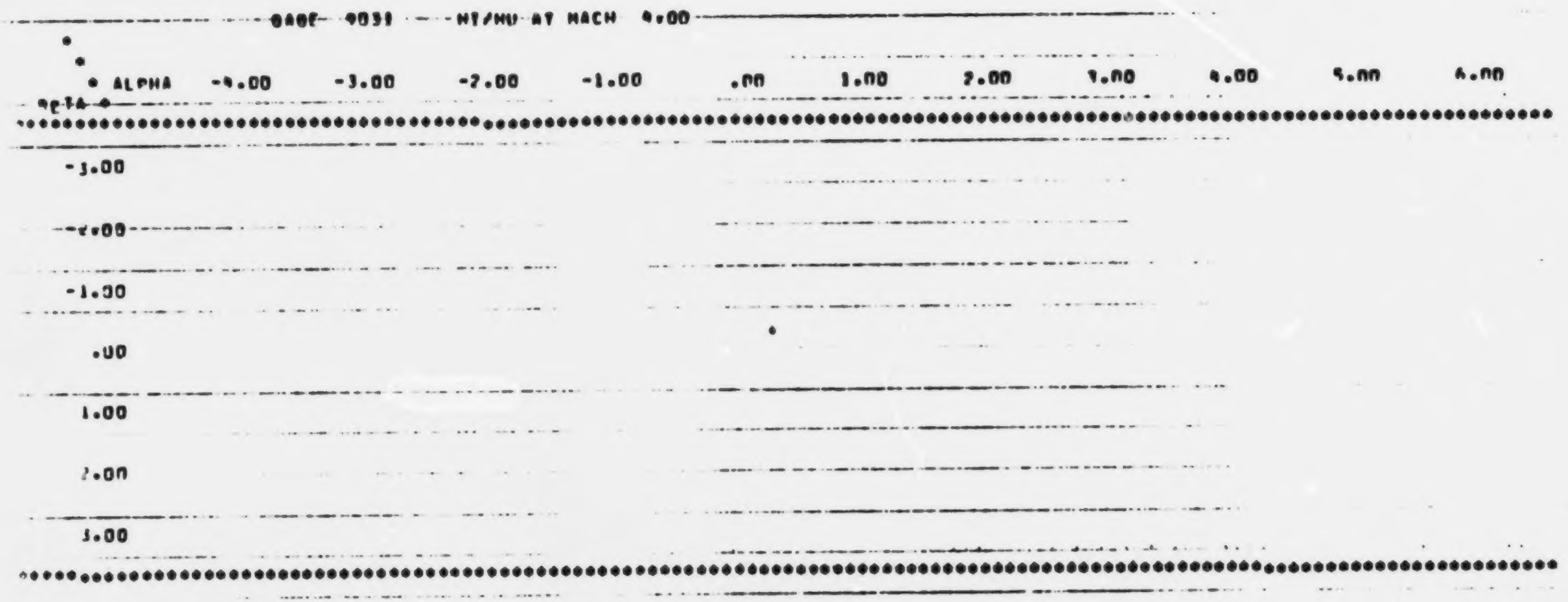
-1.00

.00

1.00

2.00

3.00



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OF POOR QUALITY

```
                    GAGE  9037  --  HT/HU AT MACH  2.50
     *
     -*
      * ALPHA   -4.00    -3.00    -2.00    -1.00     .00     1.00     2.00     3.00     4.00     5.00     6.00
BETA *
**************************************************************************************************************
   -3.00

   -2.00

   -1.00

     .00
                                                                              2.7711
    1.00                                                                      8.   3
                                                                              2.7082
    2.00                                                                      5.   5
                                                     2.9275      2.7711
                                                     0.   1      7.   3
    3.00
**************************************************************************************************************
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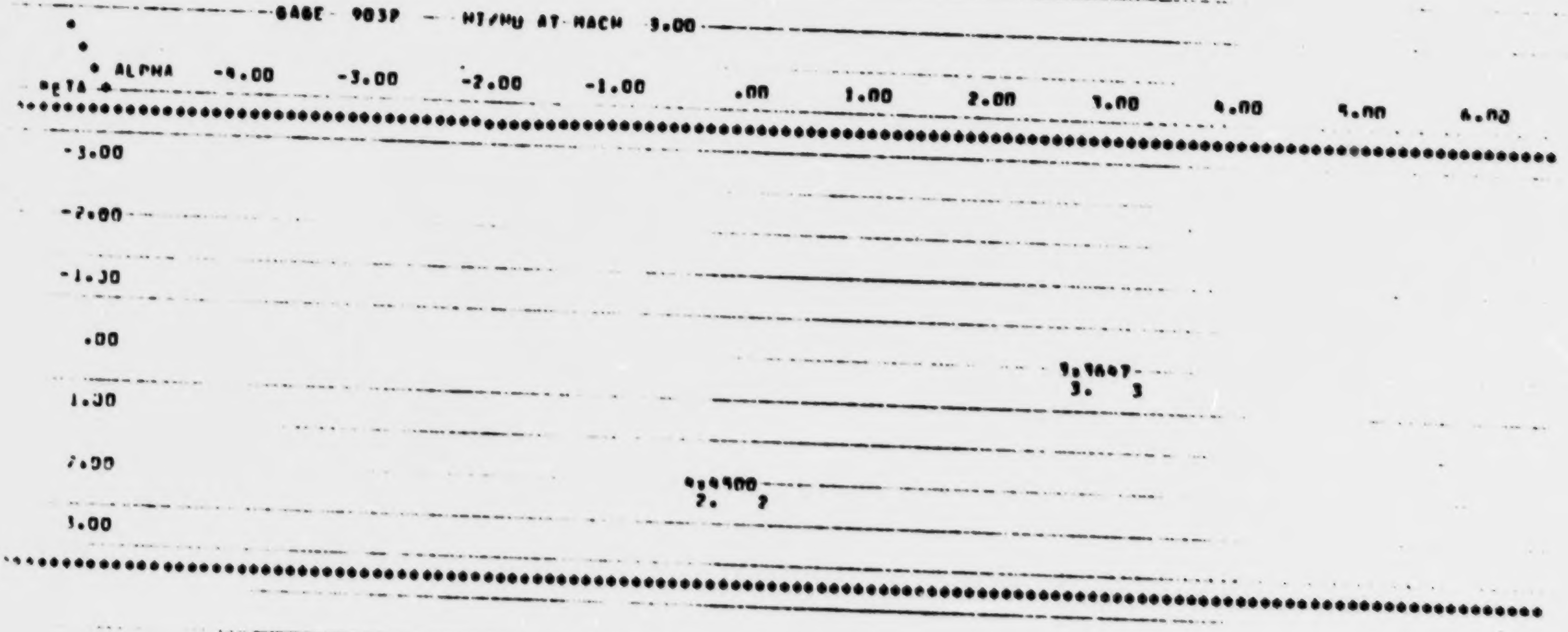

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OF POOR QUALITY

GASP 9032 — HT/HH-AT-MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00											
1.00											
2.00											
3.00											

BAGE 9032 HT/HU AT MACH 4.00

ALPHA -4.00 -3.00 -2.00 -1.00 .00 1.00 2.00 3.00 4.00 5.00 6.00

BETA

-3.00

-2.00

-1.00

.00

1.00

2.00

3.00

ORIGINAL PAGE IS
OF POOR QUALITY

CASE 9038 — HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.6098 0. 1	2.5890 2. 2	4.4376 2. 2	4.8057 1. 2		
.00						3.1121 7. 3	2.7643 16. 2	3.4759 11. 4			
1.00								5.0976 18. 5			
[illegible].30						2.9107 0. 1	2.4151 9. 3				
3.30											

BASE 903A -- MI/MU AT MACH 5.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						3.7461 0. 1	2.3177 7. 3			5.4459 7. 4	
.00					4.18076 5. 3			5.3447 4. 4		5.6094 0. 1	
1.00									5.4081 0. 1	5.4119 7. 4	
2.00					5.0426 4. 2	5.4988 4. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

BAGE 903A ---- HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						5.9819 0. 1			3.2989 0. 1		
.00					5.2735 21. 5	4.6520 12. 4	7.4175 3. 3	6.9802 0. 1	3.3606 6. 4		5.4719 21. 3
1.00						10.0620 4. 5				4.2889 0. 1	9.4551 16. 2
2.00						9.3341 3. 2				4.4396 1. 1	
3.00											

BASE 903A --- HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					6.9904 0. 1	7.7207 1. 2	5.5066 32. 4				
.00			7.4373 0. 2	6.4565 0. 1	6.3167 14. 3	6.6777 6. 2	5.5820 50. 4				
1.00		7.7701 0. 1	7.6594 3. 3	8.4968 0. 1	8.0700 17. 3	5.8512 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGE 9039 — HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.2673 0. 1	4.2911 1. 2	11.1955 2. 2	12.8460 3. 2		
.00						4.6210 10. 3	4.6328 3. 2	5.3231 59. 4			
1.00								4.7740 11. 5			
2.00						5.0006 0. 1	5.1515 5. 3				
3.00											

BASE 9039 —— MT/MU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						9.1021 0. 1	7.8562 9. 3			14.1837 4. 4	
.00					8.2216 4. 3			6.2464 7. 4		14.3830 0. 1	
1.00									8.7422 0. 1	9.4958 4. 4	
2.00					7.7537 7. 2	10.0127 5. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9039 HT/HU-AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						15.0460 0. 1			14.9300 0. 1		
.00					15.3966 10. 5	13.3032 5. 4	9.9271 4. 3	9.1974 0. 1	15.5650 7. 4		18.4500 4. 3
1.00						15.9503 3. 3				16.5960 0. 1	19.9040 3. 2
2.00						14.5345 3. 2				15.0910 4. 3	
3.00											

GAGE 9039 —— HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00					29.0910 0. 1	28.4635 4. 2	16.6907 10. 4				
1.00			28.1130 1. 2	25.2650 0. 1	24.5480 4. 3	22.2675 16. 2	18.0517 6. 4				
2.00		27.8640 0. 1	28.2063 4. 3	22.0410 0. 1	22.0937 9. 3	19.7050 0. 1					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9041 — HI/HU AT MACH 2.50

BETA * / * ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						6.6986 0. 1	6.0605 1. 2	5.6179 4. 2	7.0235 2. 2		
1.00						6.8324 9. 3	5.8674 2. 2	5.2067 6. 4			
2.00								7.1361 15. 5			
3.00						7.1709 0. 1	6.2082 8. 3				

BASE 9041 —— HI/HU-AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						13.2310 0. 1	11.9033 8. 3			11.1742 8. 4	
.00					10.5475 6. 3			9.8876 7. 4		12.9300 0. 1	
1.00									13.9210 0. 1	15.9512 6. 4	
2.00					10.5885 7. 2	12.1643 5. 3					
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGE 9043 HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						23.3510 0. 1			18.6760 0. 1		
.00					23.1616 19. 5	21.3200 6. 4	17.8707 6. 3	19.6010 0. 1	20.1162 5. 4		30.8787 5. 3
1.00						21.7903 3. 3				30.8070 0. 1	40.2990 1. 7
2.00						19.2005 2. 7				27.9843 4. 3	
3.00											

GAGE 9041 — HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					59.2720 0. 1	55.7795 2. 2	52.9845 3. 4				
.00			73.1475 9. 2	64.8330 0. 1	50.2240 17. 3	61.6860 18. 2	59.7087 14. 4				
1.00		73.2000 0. 1	71.4520 5. 3	82.4350 0. 1	80.5953 6. 3	74.8540 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9042 ---- HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						2.5189 0. 1	2.5677 1. 2	7.1424 4. 2	8.5452 3. 2		
1.00						3.6037 2. 3	3.1985 18. 2	4.9055 34. 4			
2.00								3.2325 9. 5			
3.00						3.9132 0. 1	3.4969 3. 3				

GAGE 9042 — HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						3.2444 0. 1	3.2196 1. 3			14.6047 6. 4	
.00					3.7580 1. 3			5.1147 3. 4		14.5690 0. 1	
1.00									4.7007 0. 1	4.7301 3. 4	
2.00					4.7315 4. 2	4.7504 5. 3					
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9042 — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.0867 0. 1			29.1830 0. 1		
.00					3.7611 2. 5	4.0125 3. 4	4.5030 3. 3	4.7273 0. 1	29.1325 10. 4		4.2320 3. 3
1.00						5.9378 2. 3				4.8406 0. 1	4.2257 4. 2
2.00						5.2939 7. 2				5.1539 1. 3	
3.00											

BASE 9042 ---- HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					4.4721 0. 1	4.5136 1. 2	5.4363 4. 4				
.00			5.7163 8. 2	4.6895 0. 1	4.3833 4. 3	5.5937 21. 2	5.7526 7. 4				
1.00		6.5006 0. 1	6.0369 4. 3	7.4848 0. 1	7.4211 13. 3	7.0712 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGF 9045 HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						2.9719 8. 1	3.5366 4. 2	2.8119 7. 2	2.6110 1. 2		
.00						3.8612 3. 3	3.8318 3. 2	4.5248 19. 4			
1.00								5.6805 7. 5			
2.00						6.0696 0. 1	4.9900 10. 3				
3.00											

ORIGINAL PAGE IS OF POOR QUALITY

GAGE 9045 HT/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						4.9969 0. 1	4.9500 6. 3			7.4966 2. 4	
.00					6.0325 6. 3			7.1401 4. 4		7.9862 0. 1	
1.00									9.6297 0. 1	10.2577 3. 4	
2.00					7.3862 1. 2	9.4740 6. 3					
3.00											

GAGE 9045 — HT/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						11.6840 0. 1			4.0173 0. 1		
.00					11.0330 4. 5	8.1090 10. 4	11.0373 4. 3	10.4110 0. 1	4.0975 5. 4		17.5757 5. 3
1.00						13.3053 7. 3				16.5630 0. 1	16.8070 7. 2
2.00						12.6600 2. 2				15.0643 4. 3	
3.00											

GAGE 9045 — HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					16.7020 0. 1	16.4570 2. 2	16.6727 7. 4				
.00			16.0085 3. 2	15.2150 0. 1	16.2770 4. 3	18.7315 10. 2	17.5852 8. 4				
1.00		18.0640 0. 1	17.3670 4. 3	24.2130 0. 1	23.7217+ 6. 3	20.5340 0. 1					
2.00											
3.00											

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9046 HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
						5.9604 0. 1	5.6983 0. 2	3.2097 8. 2	3.9248 3. 2		
.00											
						6.9544 1. 3	6.4130 7. 2	.7517 164. 4			
1.00											
								.0391 0. 1			
2.00											
						17.7740 0. 1	19.5023 2. 3				
3.00											

GAGE 9044 HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						8.1471 0. 1	7.8444 1. 3			5.4955 11. 4	
1.00					8.6440 2. 3			.0823 2. 4		5.7733 0. 1	
2.00											
3.00					13.3720 0. 2	13.7140 1. 3					

ORIGINAL PAGE IS
OF POOR QUALITY

GAGE 9046 — HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						9.5393 0. 1			7.2009 0. 1		
1.00					10.8500 4. 5	9.7430 3. 4	.0545 3. 3	.0513 0. 1	7.5183 14. 4		
2.00						10.0037 3. 3					
3.00						16.4655 2. 2					

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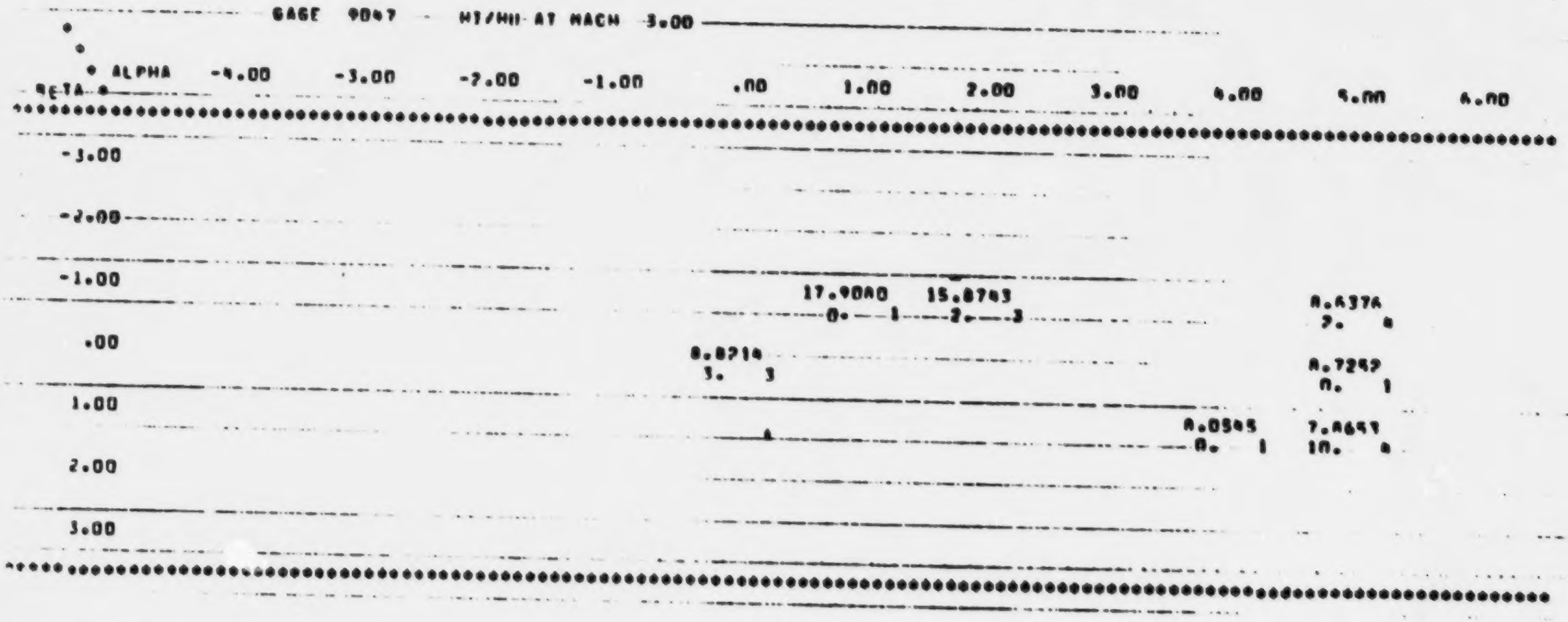
GAGE 9046 --- HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					13.7400 0. 1	13.2270 3. 2	.0221 103. 4				
.00			13.0410 12. 2	11.0140 0. 1	13.6127 12. 3	7.1353 99. 2	.0503 78. 4				
1.00		14.7830 0. 1	13.8530 5. 3	.1505 0. 1	.1459 6. 3	.1299 0. 1					
2.00											
3.00											

GAGE 9047 — MI/MU-AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						11.9800 0. 1	11.6050 2. 9	6.6352 2. 2	7.4076 1. 2		
.00						6.7017 2. 3	8.4279 19. 2	6.7592 0. 1			
1.00								5.8438 3. 4			
2.00											
3.00											



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GAGE --9047 -- HT/HO AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00						21.5210 0. 1			9.3850 0. 1		
.30					13.0906 4. 5	19.4760 1. 4			9.8002 5. 4		.0732 0. 1
1.00											.3869 71. 2
2.00										3.2229 59. 3	
3.00											

BASE 9047 HI/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					9.6244 0. 1	11.2550 6. 2					
.00			14.1265 1. 2	12.2140 0. 1	11.2020 9. 3	9.8350 0. 1					
1.00		11.5530 0. 1	12.8197 9. 8								
2.00											
3.00											

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GAGE 9020 - HI/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						3.7602 3. 3	3.7045 0. 1	4.4567 1. 3			
1.00								4.4808 0. 1			
2.00						4.6378 0. 1	4.1250 6. 3				
3.00											

GAGF 9020 — HI/HU AT MACH 3.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00					5.1992 7. 3			4.7765 3. 4			
1.00											
2.00					6.7441 5. 7	6.1564 7. 3					
3.00											

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```
GAGE 9020 -- HT/HU AT MACH 3.50
   *
    *
     * ALPHA  -4.00     -3.00     -2.00     -1.00      .00      1.00      2.00      3.00      4.00      5.00      6.00
BETA *
*****************************************************************************************************************
   -3.00

   -2.00

   -1.00

    .00
                                                    8.0016            5.9674    4.7697
                                                     7.   5            4.   3    0.   1
    1.00
                                                           8.7188
                                                            1.   3
    2.00
                                                           8.1255
                                                            1.   2
    3.00
*****************************************************************************************************************
```

GAGE 9020 HT/HU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					11.3540 0. 1	10.6900 2. 2	9.0911 3. 4				
.00			10.8220 6. 2	11.2100 0. 1	10.7730 3. 3	10.7800 1. 2	9.8319 5. 4				
1.00		10.5180 0. 1	10.5957 3. 3	12.3900 0. 1	11.9813 4. 3	11.2070 0. 1					
2.00											
3.00											

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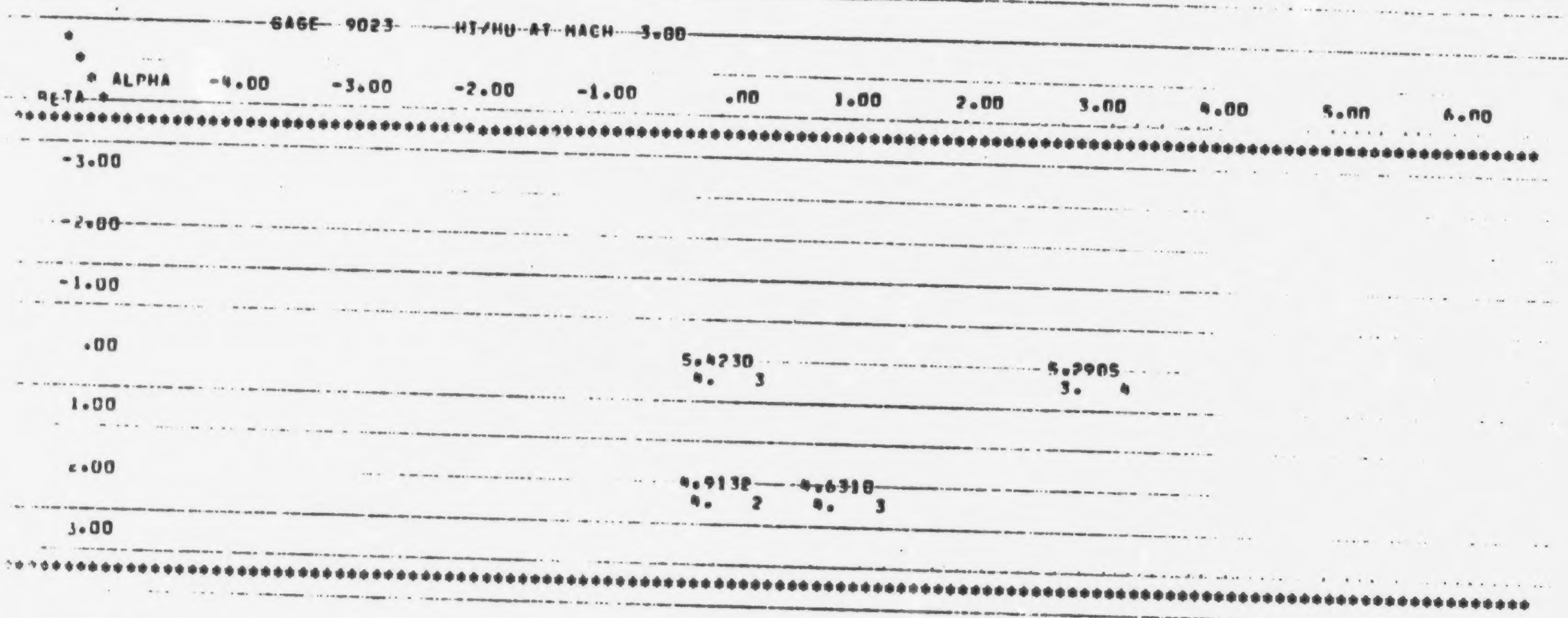
GAGE 9023 — HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00						4.4876 7. 3	3.8375 0. 1	3.5334 6. 3			
1.00								3.6497 0. 1			
2.00						4.3725 0. 1	4.1209 7. 3				
3.00											



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GAGE 9023 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00					7.4001 6. 5		6.5369 1. 3	6.4325 0. 1			
1.00						6.5711 2. 3					
2.00						6.2115 1. 2					
3.00											

BASE 9023 MI/MU AT MACH 4.00

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00					12.2750 0. 1	12.0290 3. 2	10.6190 5. 4				
.00			11.2355 6. 2	12.9880 0. 1	11.6223 4. 3	12.6485 6. 2	10.9247 11. 4				
1.00		12.3250 0. 1	11.8820 2. 3	13.8680 0. 1	13.5940 3. 3	14.0540 0. 1					
2.00											
3.00											

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GAGE 9040 --- HI/HW AT MACH 2.50

ALPHA -4.00 -3.00 -2.00 -1.00 .00 1.00 2.00 3.00 4.00 5.00 6.00

BETA

-3.00

-2.00

-1.00

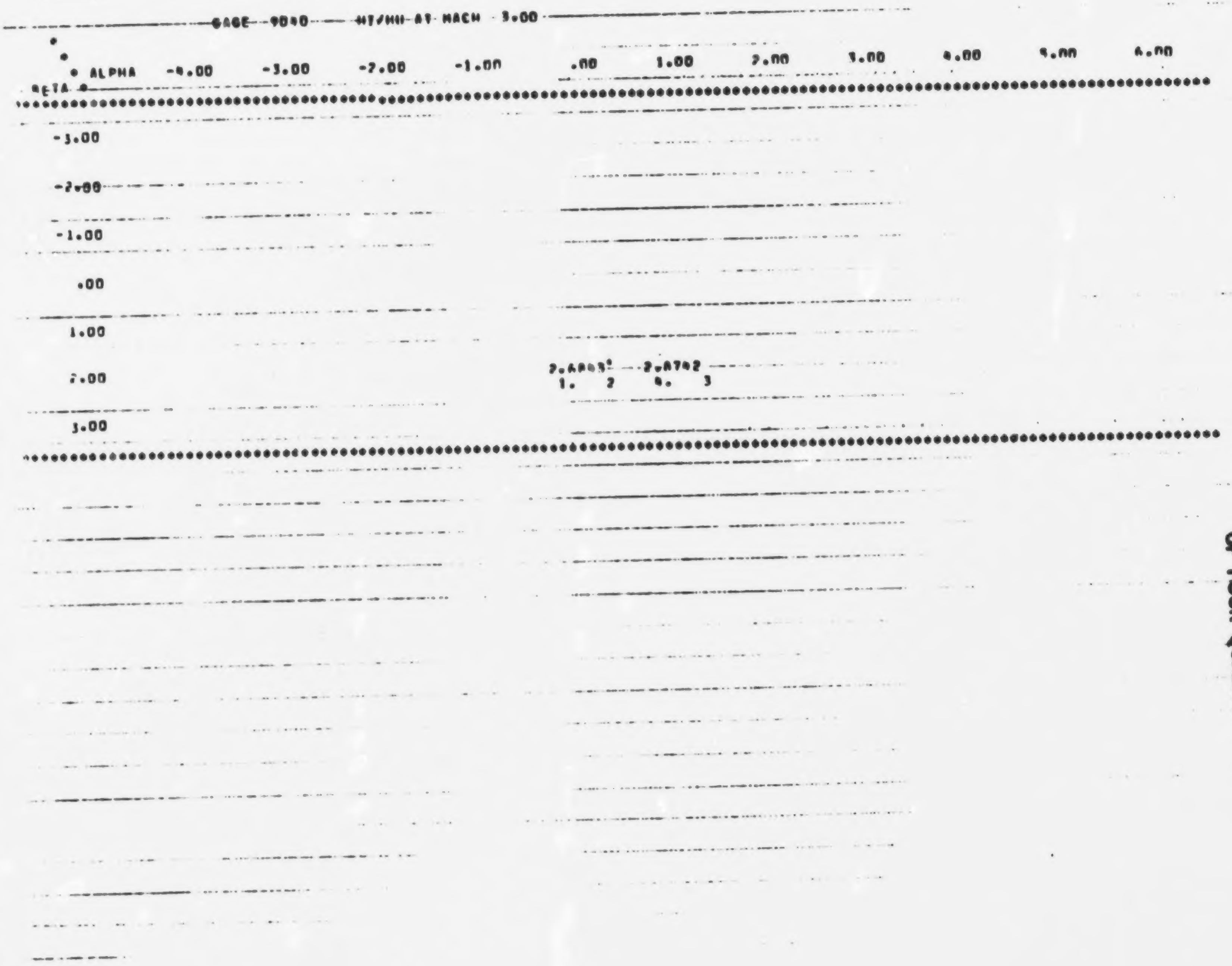
.00

1.00

2.3403 2.2136
0. 1 3. 3

4.00

3.00



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---- CASE 9040 --- MT/MM AT MACH 3.50 ----

   * ALPHA  -4.00   -3.00   -2.00   -1.00    .00    1.00    2.00    3.00    4.00    5.00    6.00
BETA *
**********************************************************************************************

 -3.00

 -2.00

 -1.00

   .00
                                                  3.5710
  1.00                                            5.   3

                                                  3.5094
  2.00                                            1.   7

  3.00
**********************************************************************************************
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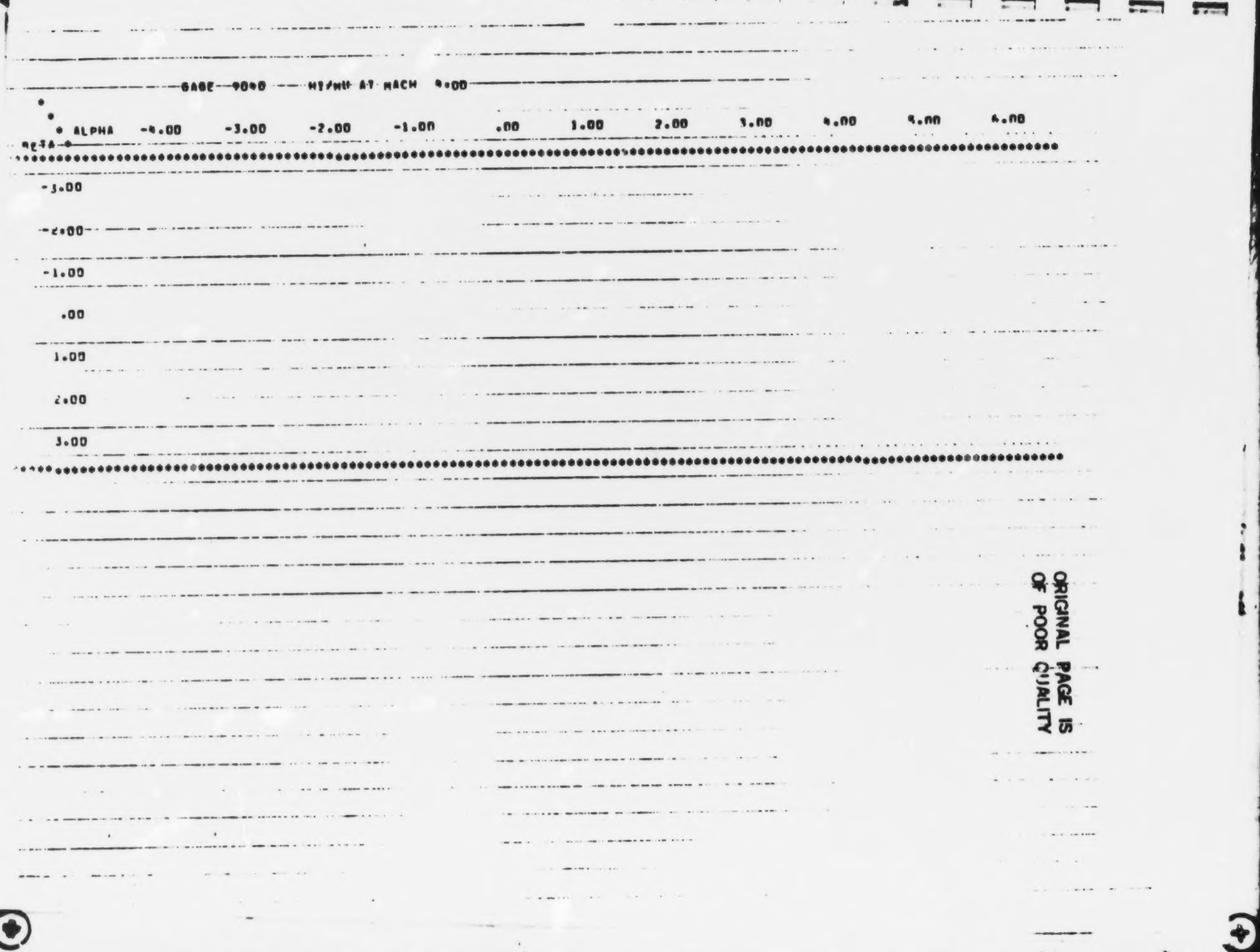

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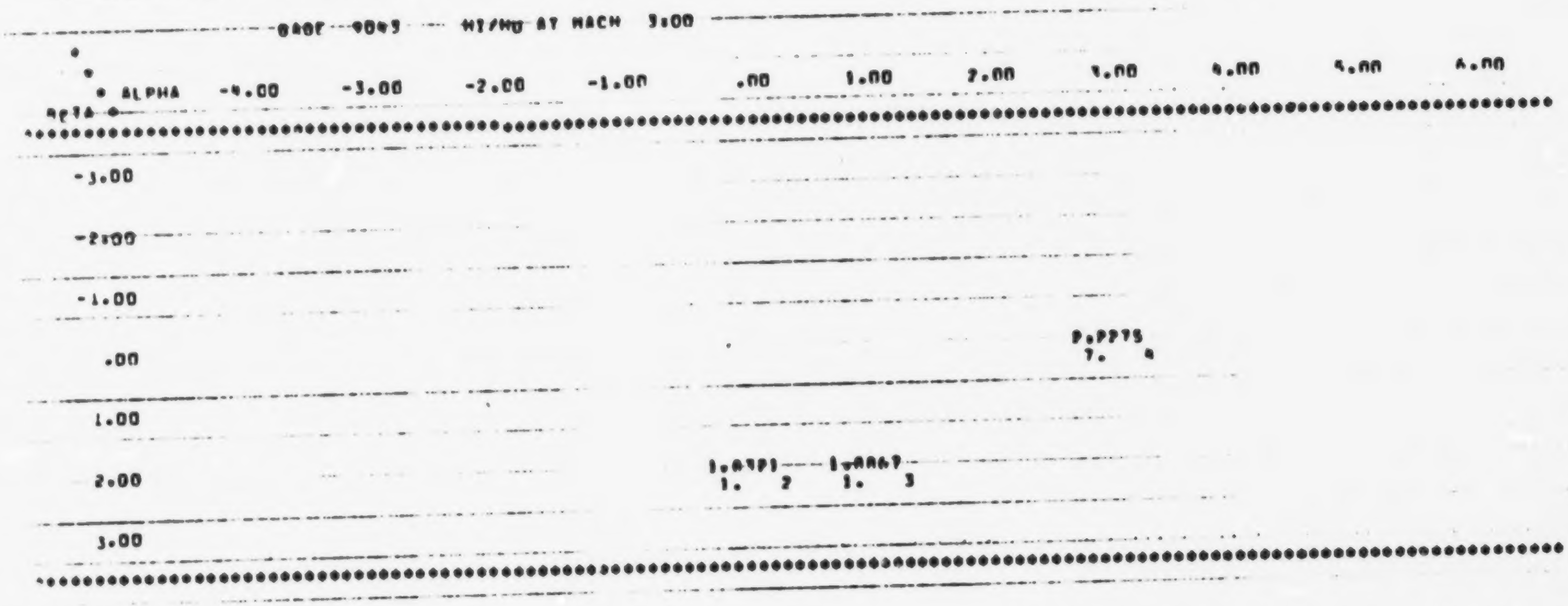
GAGE 9043 --- HT/HU AT MACH 2.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00								1.0153 4. 3			
1.00								1.7721 0. 1			
2.00						1.5114 0. 1	1.5333 1. 3				
3.00											



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CASE 0043 HI/HU AT MACH 3.50

BETA \ ALPHA	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00											
.00							2.8982 3. 3	2.8256 0. 1			
1.00						2.5348 3. 3					
2.00						2.8887 2. 2					
3.00											

GAGE 9043 HT/HU AT MACH 4.00

BETA (down) / ALPHA (across)	-4.00	-3.00	-2.00	-1.00	.00	1.00	2.00	3.00	4.00	5.00	6.00
-3.00											
-2.00											
-1.00							3.1347 4. 4				
.00						3.4790 0. 1	3.3007 4. 4				
1.00				4.2398 0. 1	4.1038 7. 3	3.6451 0. 1					
2.00											
3.00											

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NORMAL EXIT. CPU TIME: 53056 TOTAL SUPS: 173721 (MILLISECONDS)

MASG,T FILE,F//3000

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